

THE USE OF SOCIAL MEDIA IN INFORMAL SCIENTIFIC COMMUNICATION AMONG
SCHOLARS: MODELING THE MODERN INVISIBLE COLLEGE

Mohammed Ayedh Algarni, B.A., M.L.S.

Dissertation Prepared for the Degree of
DOCTOR OF PHILOSOPHY

UNIVERSITY OF NORTH TEXAS

May 2014

APPROVED:

Shawne D. Miksa, Major Professor
Barbara Schultz-Jones, Committee Member
Tandra Tyler-Wood, Committee Member
Suliman Hawamdeh, Chair of the Department
of Library and Information Sciences
Herman L. Totten, Dean of the College of
Information
Mark Wardell, Dean of the Toulouse Graduate
School

UMI Number: 3691132

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



UMI 3691132

Published by ProQuest LLC (2015). Copyright in the Dissertation held by the Author.

Microform Edition © ProQuest LLC.

All rights reserved. This work is protected against unauthorized copying under Title 17, United States Code



ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

Algarni, Mohammed Ayedh. The Use of Social Media in Informal Scientific Communication among Scholars: Modeling the Modern Invisible College. Doctor of Philosophy (Information Science), May 2014, 129 pp., 14 tables, 18 figures, references, 118 titles.

The concept of the invisible college is a key focus of scientific communication research with many studies on this topic in the literature. However, while such studies have contributed to an understanding of the invisible college, they have not adequately explained the interaction of social and structural processes in this phenomenon. As a consequence, past research has described the invisible college differently based on researchers' perspectives, resulting in misinterpretations or inconsistent definitions of the relevant social and structural processes. Information science and related disciplines have focused on the structural processes that lead to scholarly products or works while placing less emphasis on the social processes.

To advance understanding of the invisible college and its dimensions (including both social processes and structural processes), a proposed model (Modern Invisible College Model, MICM) has been built based on the history of the invisible college and Lievrouw's (1989) distinction between social and structural processes. The present study focuses on the social processes of informal communication between scholars via social media, rather than on the structural processes that lead to scholarly products or works.

A developed survey and an employed quantitative research method were applied for data collection. The research population involved 77 scholars from the Institute of Public Administration (IPA), in Saudi Arabia. Descriptive statistics, frequency and percentage were conducted for each statement. Means and standard deviations were calculated. The results indicate that the majority of participants heavily use social media for scientific communication purposes. Also, the results confirm that scholars consider social media to be an effective and

appropriate tool for scientific communication. Seven factors were found in the findings to have positive correlations with uses and gratifications theory and the use of social media.

This research contributes to and benefits scholars, reference groups (i.e., the invisible college itself), and institutions, and provides insight about the systematic development of indices for the use of informal communication channels.

Copyright 2014

by

Mohammed Ayedh Algarni

ACKNOWLEDGMENTS

This dissertation would never have come to fruition had it not been for the will of Allah Almighty. His mercy, grace, and guidance have always illuminated my path.

I would like to express profound thanks and heartfelt appreciation to my advisor and dissertation committee chair, Dr. Shawne Miksa, who has provided me with kindness, guidance, sincerity, support, positive comments, advice and valuable feedback during my years at the University of North Texas.

Sincere thanks are due to my dissertation committee members Dr. Barbara Schultz-Jones and Dr. Tandra Tyler-Wood for generously providing support and helpful comments on my work.

Special thanks and gratitude go to my friend Dr. Abdullahi Musa for his valuable advice and his friendship and collegiality as we worked together on this journey.

My father also deserves special mention. He has encouraged me to excel and to follow my dream. To my brothers and sisters, I hope they are as proud of me as I am of them.

To the special person in my life, my beloved wife Dawlah, I give special thanks. She has been with me every step of the way. It cannot have been easy for her to leave her job and home in Saudi Arabia for a foreign country; that she did so willingly has been the greatest joy to me. Without her companionship, love, prayers, and unwavering faith, I could not have accomplished this work.

My two children, Shaden and Jana, have also shared in this adventure. At times, my work has kept me from spending the time with them that they deserve. You have a bright future ahead, my children. To the memory of my mother whose soul has been omnipresent in every line I wrote. May this work be dedicated to her as a humble expression of my love and respect.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	iii
LIST OF TABLES	vii
LIST OF FIGURES	viii
Chapters	
1. INTRODUCTION	1
Background of the Study	1
Statement of the Problem.....	3
Purpose of the Study	4
Significance of the Study	5
Research Questions.....	6
Limitations of the Study.....	6
Definitions of Terms.....	7
2. LITERATURE REVIEW	9
Historical Literature on the Invisible College.....	9
The Invisible College Concept.....	13
The Modern Invisible College Model (MICM)	17
Overview of the Model of the Invisible College	17
Modeling the Modern Invisible College (Structural vs. Social Processes)	19
Social Processes	22
Informal Communication Channels in Media.....	24
Scientific Communication: The Invisible College's Activities	27

Information and Knowledge Sharing.....	30
The Use of Social Media.....	32
Social Media and Uses and Gratifications	41
Overview of Social Media and the Uses and Gratifications Theory	41
Uses and Gratifications Theory	42
Criticism of Uses and Gratifications Theory	44
Using Social Media and Use and Gratifications Theory	45
3. METHODOLOGY	47
Research Design.....	47
Research Questions.....	48
The Institute of Public Administration	49
Participants and Sample.....	50
Instrumentation	51
Validity, Reliability and Pilot Study.....	54
Data Collection Procedures.....	55
Data Analysis	56
4. RESULTS	57
Introduction.....	57
Sample Profile.....	57
Gender Profile.....	59
Age Profile	59
Academic Ranks Profile	60
Academic Field Profile	61

Distribution of the Rate of Social Media Use for Scientific Communication	62
Gender and Using Social Media Tools as Scientific Communication Tools.....	73
Age and Using Social Media Tools as Scientific Communication Tools.....	74
Academic Ranks and Using Social Media as Scientific Communication Tools ..	75
Academic Field and Using Social Media as Scientific Communication Tools	76
Faculty Members Comments and Suggestions	79
5. DISCUSSION AND CONCLUSIONS	81
Interpretation of Findings	81
Rate of Social Media Use for Scientific Communication.....	81
Gender, Age, Academic Ranks and Academic Field and Using Social Media Tools	87
Contributions and Limitations	90
Implications and Conclusions.....	93
Recommendations.....	95
Appendices	
A. ENGLISH VERSION OF THE SURVEY	98
B. ARABIC VERSION OF THE SURVEY	104
C. LETTER OF ACCEPTANCE BY UNIVERSITY OF NORTH TEXAS INSTITUTIONAL REVIEW BOARD.....	110
D. INTRODUCTORY LETTER TO FACULTY MEMBERS OF INSTITUTE OF PUBIC ADMINISTRATION (ENGLISH AND ARABIC VERSIONS).....	112
REFERENCES	117

LIST OF TABLES

	Page
1. Distribution of IPA Faculty Members by Academic Field.....	51
2. Demographic Data of IPA Respondents.....	58
3. Use of Social Media for Scientific Communication Purposes.....	62
4. Technology Use for Accessing Social Media Platforms for Communication.....	64
5. Social Media Tools as Scientific Communication Channels.....	65
6. Appropriate Informal Communication Channel.....	67
7. Social Media Tools Used Most Frequently as Channels of Scientific Communication...	68
8. Reasons to Use Social Media for Scientific Communication.....	69
9. Scholars Perceive Social Media as Useful for Scientific Communication.....	71
10. The Relationship Between Gender and Social Media for Scientific Communication.....	73
11. The Relationship Between Age and Using Social Media for Scientific Communication	74
12. The Relationship Between Academic Ranks and Using Social Media for Scientific Communication.....	75
13. The Relationship Between Academic Field and Using Social Media for Scientific Communication.....	77
14. Barriers Prevent Scholars From Using Social Media Tools for Scientific Communication Purposes.....	78

LIST OF FIGURES

	Page
1. Structurally informal value-added model for the study of scientific organization ...	16
2. The modern invisible college (MICM).....	20
3. The modern invisible college: Social processes vs. structural processes.	20
4. The modern invisible college: Structural processes.....	21
5. Factors affecting communication channel choices in science	23
6. The modern invisible college: Social processes.	27
7. The modern invisible college: Social processes that focus on social media.....	29
8. Social media timeline.....	37
9. Conceptual framework of scholars' use of social media.....	39
10. Gender distribution within the study sample.	59
11. Age categories for the study sample.	60
12. Academic ranks for the study sample.	60
13. Academic field for the study sample.	61
14. Scholars use of social media for scientific communication purposes.....	63
15. Technology use for accessing social media platforms for communication.	64
16. Social media tools used as scientific communication channels.....	66
17. Social media tools most frequently used as channels of scientific communication.	69
18. The modern invisible college: Social processes that focus on social media.....	91

CHAPTER 1

INTRODUCTION

Background of the Study

The concept of the invisible college is a key focus of scientific communication research, and many studies have been conducted on this phenomenon, as reported in the next chapter. The invisible college is a social system that consists of scholars (subsystems) who interact, communicate, share, and exchange information and knowledge informally via certain channels. Communication among scholars is an essential part of scientific work; it constitutes the social processes by which scholars establish their relationships and interact through informal communication channels.

In recent years, a new paradigm has revolutionized informal communication channels: social media, now an extremely popular communication tool and the most common activity carried out via the Internet for most individuals worldwide. Social media facilitate the procedures of accessing, communicating, and sharing information, knowledge, and resources with others. Informal communication channels have existed for a long time, but have become increasingly important as improvements in information technology have made these communication channels easier to access and operate. As these new channels are extremely useful resources for scholars and academic work, access to them should be easy and convenient. Providing this access requires consideration of *what*, *who*, and *how* questions with regard to informal academic communication. In this case, the *what* is social media, the *who* is its academic users, and the *how* is the means by which scholars interact today as compared to the past. Effective access to new informal communication channels, especially social media, is today's challenge and tomorrow's opportunity.

Social media tools are facilitating connection and communication between individuals and groups to raise awareness of available services, and therefore to extend and expand upon existing academic conversations and research. New social media tools promote diversity and facilitate communication with a large number of persons in a convenient manner. These new technologies offer unprecedented insights into new dimensions in the field of scientific communication. Modern technology has radically changed the processes of scientific communication, affecting how scholars undertake informal communication activities and how they interact or collaborate with their colleagues. Borgman (1993) pointed out that communication technology has vastly enhanced informal scholarly conversations and, consequently, scholarship in general (p. 241).

Due to the fast and easily accessible forms of communication provided by advanced technologies, scholars can expand and enhance their communications with the invisible college around the world. Technology has made it possible for scholars on opposite sides of the globe to discuss scientific and academic issues online. As technology advances, scientific communication methods will advance as well. Scholars accept and welcome digital communication technology because it enhances the research process in terms of both efficiency and accuracy. The availability of resources is broad and immediate (Borgman, 1993, p. 241).

As Garvey (1979) stated, “Communication is the essence of science” (p. ix). It is abundantly clear that a large part of science involves social activity (e.g., the communication of research results). This communication occurs informally through social processes within the invisible college, as well as within specific, informal networks formed for the purpose of sharing and exchanging scientific information and knowledge; the concept of scientific communication has generally been used, however, only to these more formal methods of information exchange.

Statement of the Problem

Past research on scientific communication, in the information science field or other related disciplines, has used the term “invisible college” inconsistently (Lievrouw, 1989; Zuccala, 2006). The origin of the invisible college phenomenon has not been investigated properly because of misinterpretations of key events in its development. Meanwhile, other studies have focused on structural processes as informal communication instead of considering these processes as formal channels (even if they are electronic in nature) focused on products and contents of scholarship (i.e., publications, documents, citation data, and the contents of websites and blogs); hence, those studies have been used to assess the growth of scientific literature and cooperative work (Crane, 1972; Lievrouw, 1989; Price, 1963; Zuccala, 2006). In turn, the actual communication processes among scholars who perform scientific work must be included in social processes (Lievrouw, 1989; Zuccala, 2006). However, there is little to no emphasis on these social processes. While, in the past, researchers have focused on one aspect of the invisible college—its structural processes (Lievrouw, 1989; Zuccala, 2006)—no one has paid comparable attention to the social processes that occur within informal communication networks of scholars (Lievrouw, 1989). The present research focuses on this overlooked aspect of the invisible college, namely its social processes and informal communication channels, particularly the use of social media. The social context “strongly influences the degree to which technological opportunities may facilitate the communication process in science” (Caldas, 2002, p. 1). Specifically, past studies have generally not provided clear evidence of scholars’ use of informal communication channels (such as social media) for the purpose of scientific communication. Understanding communication processes within the invisible college more fully will enable

researchers to recognize what underlying considerations are important in the use of social media for informal scientific communications among scholars.

Purpose of the Study

By examining the scholarly use of social media for scientific communication, this study aims to facilitate understanding of the fundamental goal of the invisible college through development of a proposed research model. The study was drawn on a conceptual framework known as uses and gratifications theory to demonstrate the ways in which scholars decide to use a particular social media tool. Additionally, by way of background, this study reviews the history of the invisible college and important events that contribute to an understanding of its nature and identity.

There are two reasons to focus on this particular phenomenon. First, the goals of the invisible college have been misinterpreted by past research, and a more detailed revisiting and extensive analysis of the phenomenon will fill a gap in the research. Second, the development of the proposed model, incorporating both social processes and structural processes in the invisible college (see Figure 3 in chapter 2), will facilitate understanding of the invisible college's fundamental goals. This model demonstrates clearly that the invisible college consists of two main components: social processes (which have not been fully explored and was thus the focus of the present study) and structural processes, which were excluded from this study as they have received ample attention previously. Each component takes a distinct direction and includes different activities (see Figure 3).

The results of this study will aid researchers, academic practitioners, and current and future participants in the invisible college to better understand the invisible college phenomenon, its social processes, and its informal communication channels. Moreover, the results could

contribute to enhancement of the services available through informal communication channels including social media. They should provide crucial information for the minds behind informal communication channels (e.g., social media developers) to improve applications to scientific communication.

Significance of the Study

Recent studies have shown that the use of social media has become especially significant at the academic level, especially among scholars. Grosseck, Bran, and Tiru (2011) emphasized that instructors at the university level are recognizing the significance and effectiveness of social media for academic purposes (p. 1425). However, studies that directly explore the use of social media among scholars are limited in number.

Although the body of research on social media is growing, the focus and direction of this research vary radically. These significant differences regarding the phenomenon of social media in various online communication channels can be related largely to the perspective of uses and gratifications theory and dominant social media. This evidence has significant implications for the delivery of social media services and for further development of theory.

This study's most immediate contribution lies in its investigation of scholars' perceptions regarding their social media use. This study provides significant data and information that can help future researchers to understand the modern invisible college phenomenon and informal scientific communication among scholars via social media. In addition, scholars may use the findings of this study to enhance collaboration and sharing of information, knowledge, and resources. Greater understanding will lead to enhanced application and use of communication and information technology for scientific purposes. The study is therefore important because it provides new information on the use of social media and the invisible college phenomenon.

Research Questions

This study explores scholars' perceptions of practical use of informal communication channels and social media tools for scientific communication among the scholars at the Institute of Public Administration in Saudi Arabia. It seeks to interpret these responses in terms of uses and gratifications theory. Research questions have been formulated to engage the participants in articulating their understanding of the role of social media in scientific communication. The following research questions are addressed:

1. To what extent are the scholars at the Institute of Public Administration using social media for scientific communication?
 - a. How do these scholars decide which informal communication channel is appropriate for their communication?
 - b. What social media do scholars use most frequently for scientific communication?
2. Why do scholars use social media for scientific communication?
 - a. To what extent do these scholars perceive social media as useful for scientific communication?
 - b. What factors influence scholars' perceptions of using social media tools for scientific communication?
3. How can uses and gratifications theory explain the use of social media among scholars for scientific communication?

Limitations of the Study

This study focuses on the phenomenon of social media tools as informal communication channels; thus the findings might not be generalizable to other informal communication channels. The study examines scholars at only one organization, the Institute of Public

Administration (IPA), located in Saudi Arabia, so the findings may not be generalizable to other organizations or governmental agencies in Saudi Arabia or elsewhere in the world.

Furthermore, the population for this study includes only faculty members who hold Ph.D. degrees, and thus findings may not be applicable to other faculty members who do not have a doctoral degree. The samples from the male group were largely greater than the samples from the female group. This is because there are fewer Ph.D. degree holders in the female group than in the male group. Despite the equalization of scholars' numbers in the academic fields part, some academic fields have larger numbers of scholars such as law and human resources management fields. Also, the fact that the researcher is a colleague of this faculty at the IPA might affect the validity of the participants' responses.

Lastly, this study used only a quantitative research method to collect statistical data and so it may not unveil all of the participants' feedback.

Definitions of Terms

Invisible college: Lievrouw's (1989) definition of the invisible college is "a set of informal communication relations among scholars or researchers who share a specific common interest or goal" (p. 622). For the purpose of this present study, "invisible college" refers to a set of subsystems (scholars) within a system (a group with official or unofficial members) who use informal communication channels for scientific communication.

Knowledge sharing: Any exchange or distribution of information between groups or individuals (Lee, 2001).

Reference group of scientists: Colleagues drawn from several membership groups.

Social media: A variety of informal online channels, sites, platforms, and mobile phone applications that provide services to individuals or groups for various activities, such as

exchanging and sharing information and knowledge in textual, pictorial, audio, or video formats, or other multimedia communications that reflect social networks and relations among individuals who share similar interests and activities.

Subsystem: A single scientist or scholar within the group referred to as a system.

System: A group consisting of official or unofficial members who have common or similar academic and research backgrounds and other related and similar traits (Paisley, 1968, p. 5).

Uses and gratifications theory: According to Papacarissi (2009), uses and gratifications theory is a psychological view of communication that focuses on the way in which individuals use mass media. Katz (1959) suggested that this theory concentrates not on the question “What do the media do to people?” but on “What do people do with the media?” (p. 2).

CHAPTER 2

LITERATURE REVIEW

This chapter reviews prior research relevant to the study topic. It covers the concept and history of the invisible college, modeling of the modern invisible college, informal communication channels in media, and the use of social media. While constructing a model of the invisible college, the modern invisible college model (MICM), is the major objective so the focus of this study is on social processes within the invisible college.

Historical Literature on the Invisible College

Fulton (1932) stated that in order to understand modern science and intellectual development accurately it is necessary to study and understand our origins. This observation certainly applies to the often-misunderstood concept of the invisible college.

Webster (1974), a British medical historian, made a major contribution to our understanding of the identity of the invisible college by analyzing its contents (e.g., correspondence between scholars) and the historical development of the concept. In addition, studies by Fulton (1932), Hunter and Littleton (2001), and Hunter (2004) have played a significant role in shaping our understanding of the history of the invisible college and identifying its so-called founder, Robert Boyle.

In recent years, researchers interested in the invisible college have attempted to build on particular existing studies. For instance, Derek de Solla Price's 1963 work and Diana Crane's 1972 study have been the most frequently cited works by researchers writing on scientific communication, scholarly communication, the invisible college phenomenon, citation structures, and the growth of science. Most recent researchers have relied on Price and Crane as authorities on the origin of the invisible college. Despite their contributions to the study of scientific

communication, however, the major weakness of their studies is that they neglect the historical aspects of the invisible college phenomenon. For example, Lievrouw (1989) criticized Crane's (1972) study and other similar studies because of their misinterpretation of the concept of the invisible college and the resulting misinterpretations of its nature and purpose. The present study thus seeks to examine issues of history and conceptual interpretation more rigorously.

The term "invisible college" appears to have been coined by Robert Boyle in 1646, who was among the most respected British scholars and scientists and one of the founders of modern chemistry in the 17th century. According to Webster (1974), Robert Boyle was born on January 27, 1627, at Lismore Castle in Lismore, Ireland. By his teenage years he showed a strong passion for natural philosophy. In 1641 Boyle began a tour of Europe, returning to England in 1644. Fulton (1932) stated that Boyle "found himself the center of an active group who, after 1645, began to meet together from time to time with a view to discussing scientific problems and to increasing natural knowledge by means of experiment" (p. 84). Webster (1974) contended that the invisible college was "established" around 1646 when experimental science and the elements involved in its foundation were gaining prominence in England (p. 19). Around this time Boyle joined a group whose aim was to cultivate ideas and acquire knowledge through experimental investigation, he called this approach the "new philosophy" or the "invisible college."

Fundamentally, the invisible college of Boyle's time was a network of individuals who communicated through letters and in regular meetings at individuals' homes and in laboratories in order to acquire and share knowledge and to carry out experimental investigation in a wide array of disciplines such as chemistry and natural philosophy.

In spite of these historical references by Boyle, absolute recognition of the establishment of the invisible college is next to impossible due to a lack of formal evidence (Webster, 1974).

Accordingly, Webster looked to Boyle's letters (available in the Sheffield University library), samples of which are reproduced in his work. Webster indicated that the only explicit evidence of the college comes from direct references in correspondence written by Boyle, who actually used the term three times. The first evidence of the existence of the term was an October 22, 1646, letter written to Boyle's former tutor, Isaac Marcombes of Geneva, in which Boyle briefly explained the goal of an "invisible college" or a "philosophical college" (Webster, 1974, p. 19).

Boyle wrote to Marcombes:

The other humane studies I apply myself to, are natural philosophy, the mechanics, and husbandry, according to the principles of our new philosophical college, that values no knowledge, but as it hath a tendency to use. And therefore I shall make it one of my suits to you, that you would take the pains to enquire a little more thoroughly into the ways of husbandry, & C. practised in your parts; and when you intend for English, to bring along with you what good receipts or choice books of any of these subjects you can procure; which will make you extremely welcome to our *invisible college*. (Boyle, 1756, as cited in Webster, 1974, pp. 19-20)

The second piece of evidence, taken from a letter that Boyle wrote to Samuel Hartlib on May 8, 1647, provides significant insight into the phenomenon:

You interest yourself so much in the *Invisible College*, and that whole society is so highly concerned in all the accidents of your life, that you can send me no intelligence of your own affairs, that does not (at least rationally) assume the nature of *Utopian*. (Boyle, 1756, as cited in Webster, 1974, p. 20)

Webster's study leaves no room for doubt about the origin of the invisible college due to his verification of the primary source references of this phenomenon. Webster further explained that Boyle's letters contained comments about proposals for the "college" and that he applied the term to a wide variety of projects. In this regard, the invisible college can be seen as a set of subsystems (i.e., scholars) that communicate and collaborate with other subsystems for scientific works in multiple projects within the umbrella of the main system, which is the invisible college itself. A scholar can be considered a subsystem when he or she functions within a work team.

Paisley (1968) stated that a work team provides the individual scientist with “rich, non-redundant information through conversation” (p. 6). A scientist’s community provides him with additional resources, but none are as substantial as what he can attain within the system known as the invisible college (Paisley, 1968, p. 6).

Webster (1974) contended that Boyle’s correspondents would have understood the meanings that Boyle intended in his letters, and that subsequent misinterpretations of the invisible college have occurred because other theorists described the concept inaccurately, creating a foundation upon which future academics would build additional faulty research (p. 21). For instance, Paisley (1972) asserted, “Investigators of invisible colleges are frustrated by their phantom concept, which is too reminiscent of phlogiston and ether” (p. 7). In contrast, Boyle’s editor, Thomas Birch, whose ‘supposition has with the passage of time acquired almost the authority of definitive interpretation’ (McKie, 1960, p. 21) of the invisible college, understood the term as a sort of informal assembly for the purposes of engaging in intellectual conversation. Birch believed that

the Invisible College ... probably refers to that assembly of learned and curious gentlemen, who, after the breaking out of the civil wars, in order to divert themselves from those melancholy scenes, applied themselves to experimental inquiries, and the study of nature, which was then called the new philosophy, and at length gave birth to the Royal Society. (Boyle, 1756, as cited in Webster, 1974, p. 21)

Past researchers have indicated that the invisible college was the main precursor of the British Royal Society, but Webster concluded that it was not. McKie (1960), too, concluded that Birch’s supposition was incorrect (p. 21).

In modern times the number of scholars and the breadth of scholarly disciplines have gradually increased. The growth of the sciences in the 20th and 21st centuries has been far greater than during any previous century, and incredible advancements in technology have made

possible an accelerated dispersion and advancement of knowledge. Further, more people are considered scholars today than ever before. Price (1963) observed that 80 to 90 percent of all scientists who have ever lived were alive during the 1950s. As modern science continued to grow, the term “Big Science” came to be used to describe its expansive nature (Price, 1963, pp. 1-2). In addition, Wagner (2008) indicated that the expansion of higher education and the simultaneous growth in prestige of science and engineering have resulted in more people entering these fields. Consequently, the invisible college of modern times is larger, more professional, and more identifiable as a significant phenomenon than it was in Boyle’s time (p. 22).

The Invisible College Concept

The term “invisible college” has been studied in various disciplines, including science (Price, 1963; Garvey, 1979), information science, communication (Paisley, 1984), modern medicine (Webster, 1974), and history (Fulton, 1932), yet, a consensus understanding of the concept has not yet been reached. According to Paisley (1984), the varied and inconclusive studies on the concept of the invisible college demonstrate that understanding is indeed invisible (p. 14).

Despite the significance and effectiveness of the invisible college, Lievrouw (1989) observed that its meaning and function are difficult to articulate, understand, and transmit as an idea, and that therefore it has been interpreted and documented in a variety of ways by various researchers (p. 616).

Many studies emphasize (inaccurately) that the term *invisible college* first appeared at the time of the founding of the Royal Society of London in the 17th century (Price, 1963; Crane, 1972; Lievrouw, 1989). In the 20th century, the term “invisible college” was used by Derek de

Solla Price (1963) in his book *Little Science, Big Science* to indicate an informal communication network of scholars (e.g., elite scholars from different research areas). Price stated that the members of such a group have similar backgrounds and interests and enjoy engaging in intellectual and scientific discourse. He further explained that these group members typically congregate in casual settings to communicate and participate in collaborative research (Price, 1986, p. 119).

Research such as Price's has revealed that, in the past, close interpersonal relationships were limited to specific groups, while today's modern network technology makes it possible for scholars to communicate across great geographic distances as well as across disciplines and to establish relationships with others who share similar interests and goals. For instance, researchers investigating similar topics are able to build contacts through social networks and participate in discourse; this activity has been frequently described as the invisible college (Tuire & Erno, 2001, p. 498).

According to Lievrouw (1989), clarifying the meaning of the invisible college is problematic because past studies have misinterpreted the concept and its goals. Lievrouw provided valuable comments and recommendations for researchers with regard to these misunderstandings. Accordingly, the design of the proposed model is based on Lievrouw's perspective.

Additionally, Lievrouw (1989) contributed to a better understanding of the invisible college concept by articulating the difference between social and structural processes. Lievrouw criticized Crane's 1972 study and others, indicating, for example, that Crane's interpretation of the invisible college concept is "ambiguous" (p. 622). The term has taken on various meanings

and has frequently been used for different purposes because researchers have misunderstood the meaning of the invisible college.

Paisley's (1968) article titled "Information Needs and Uses" has been influential on the subject of the invisible college, because he introduced the word *system* for the invisible college and *subsystems* for the individual scholars or scientists. Paisley (1968) stated that an invisible college consists of a group of scholars—usually fewer than 100—who share information directly. According to Paisley (1968), the scholars know each other and this familiarity leads to the development of a select and limited group.

Past studies have provided various definitions for the invisible college, as researchers viewed the concept from various perspectives, perhaps producing more confusion than understanding. Lievrouw (1989) stated that, in place of the common understanding of the invisible college as an "informal social phenomenon," an updated definition was needed. He proposed this definition: "An invisible college is a set of informal communication relations among scholars or researchers who share a specific common interest or goal" (p. 622). Despite Lievrouw's clear explanation of the invisible college, recent studies conducted by Zuccala (2006) misinterpreted the definition of the invisible college and its two aspects. Zuccala's model, illustrated in Figure 1, referred to formal and informal communications channels. Zuccala considered bibliometric artifacts (i.e., production of scholarly works) to be one of the formal communication channels between social actors. It is important to distinguish between formal channels and formal communication, as is illustrated in the proposed model (see Figure 2). The present study corrects this concept by illustrating the difference between formal and informal communication channels (see Figure 3).

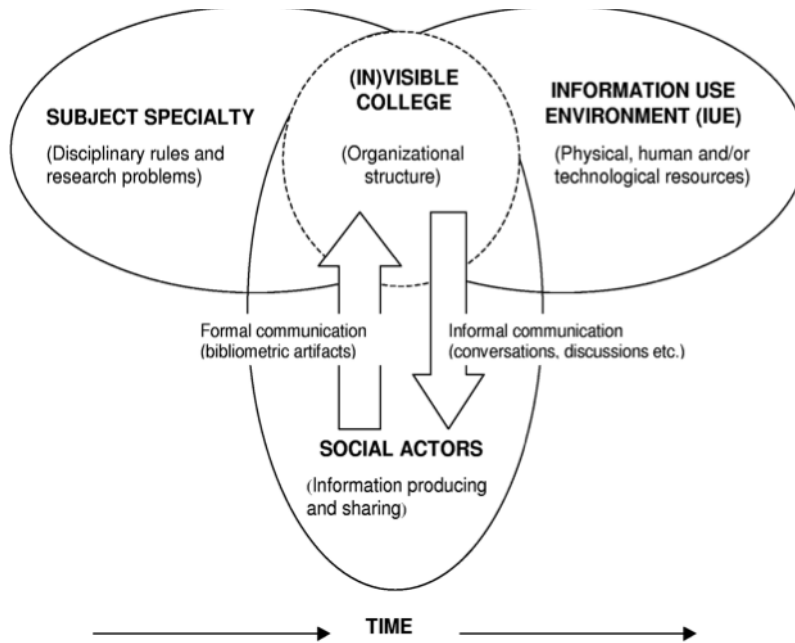


Figure 1. Structurally informal value-added model for the study of scientific organization (taken from Zuccala, 2006, p. 156).

Zuccala (2006) defined the invisible college as

a set of interacting scholars or scientists who share similar research interests concerning a subject specialty, who often produce publications relevant to this subject and who communicate both formally and informally with one another to work towards important goals in the subject, even though they may belong to geographically distant research affiliates. (p. 155)

While Zuccala provided an interesting definition for the invisible college, Lievrouw (1989), Paisley (1968), and the present study all have stressed that the invisible college system intends to communicate informally rather than formally. Due to the nature of the relationships between scholars within the invisible college system, the scholars do not specifically represent their organizations or have to belong to specific organizations in order to use the available formal channels to communicate. In addition, Zuccala's definition limited communication between scholars to "important goals," which would mean that scholars who communicate without having significant issues or goals in mind would not be functioning as members of the invisible college.

To clarify the meaning of the invisible college, the present study defines it as a set of subsystems (scholars) within a system (a group with official or unofficial members) that use informal communication channels for scientific communication. By this definition, it is clear that the invisible college can be seen as a set of subsystems (i.e., scholars) that communicate and collaborate with other subsystems for scientific knowledge or works in multiple projects under the umbrella of the main system, which is the invisible college. Scientific communication means that scholars communicate, collaborate, and/or share a specific common interest or goal in a specific area.

Past research has revealed the goals of the invisible college. Crane (1972), Lievrouw (1989), and Price (1963) confirmed that the invisible college relies on informal communication and personal contact with colleagues to share information and knowledge. In this regard, the invisible college can benefit from peers' personal information and knowledge and satisfy information needs, as is illustrated later in this chapter.

The Modern Invisible College Model (MICM)

Overview of the Model of the Invisible College

The invisible college is a key focus of scientific communication studies, and many research studies on this topic and related issues can be found in the literature. However, while such studies have helped in understanding the invisible college phenomenon, these studies lack an adequate explanation of social and structural processes and how they differ from each other. As a consequence, past studies have described the invisible college differently based on researchers' misperceptions, leading in turn to a misinterpretation of the meaning of social and structure processes. For example, information science and related disciplines have focused on

structural processes, such as measuring the growth of science, while placing less importance on social processes.

To advance understanding of the invisible college and its dimensions (i.e., social vs. structural processes), a proposed model has been built based on the history of the invisible college and drawing on Lievrouw's (1989) article that specifically distinguished between social and structural processes in the invisible college's procedures.

The key constructs of the invisible college have emerged from multidisciplinary literature reviews in the fields of science (Price, 1963), information science (Garvey, 1979), communication (Paisley, 1968), modern medicine (Webster, 1974), history (Fulton, 1932), and interdisciplinary science (Cruz & Jamias, 2013). Accordingly, the invisible college is the most recognized example of scientific communication (Lievrouw, 1989, p. 616). The model of the invisible college proposed here can be applied generically in different settings. The key significance of the invisible college lies in its precision and clarity and in its potential to elucidate a specific process.

This model clarifies the difference between the two processes of the invisible college by narrowing the broad view of the concept. It also proposes social process techniques based on the benefits of informal communication channels from the end user perspective (i.e., scholars within the invisible college system), unlike earlier views of the invisible college techniques reported in the literature, in which the communication processes were classified based on their form and structure.

The model also clarifies the complexity surrounding the concept of the invisible college by providing illustrations and answers for future researchers who may use this model to investigate different parts or aspects of the modern invisible college. It addresses such questions

as: What processes are to be used to examine the invisible college? What activities are used for informal communication within the invisible college? What types of informal communication channels does the invisible college use? What format does the invisible college use for reaching colleagues? How does the invisible college communicate with colleagues?

This proposed view moves away from the broader, generalized view of the invisible college that treats its objective as equivalent with the factors responsible for scholarly communication, i.e., formal and structured communication channels that lead to scientific works or products (e.g. books, articles) and bibliometrics. Further discussion of the literature on scholarly communication and the measurement of scientific growth, or bibliometrics, can be found in studies by Price (1963), Crane (1975), amongst others.

Modeling the Modern Invisible College (Structural vs. Social Processes)

To gain new insight into the invisible college phenomenon, the proposed model (see Figure 2) illustrates the real goal of the invisible college, which has been misinterpreted by past research. As Lievrouw (1989, p. 618) pointed out, while many scientists have studied the social structures of the sciences, few have focused on the communication processes. Crane's model of the communication aspects of scholarship has, therefore, become the predominant one. It is important to distinguish between the two techniques of the invisible college, namely the social processes and the structural processes (see Figure 3). As is explained, there is no relationship between two forms of communication because each one has its own processes and goals. The main problem is that past research views communication between scholars as occurring through both methods, which is not entirely accurate.

The Modern Invisible College Model (MICM)
 Created by: Mohammed A. Algarni
 University of North Texas
 College of Information
 ©2013

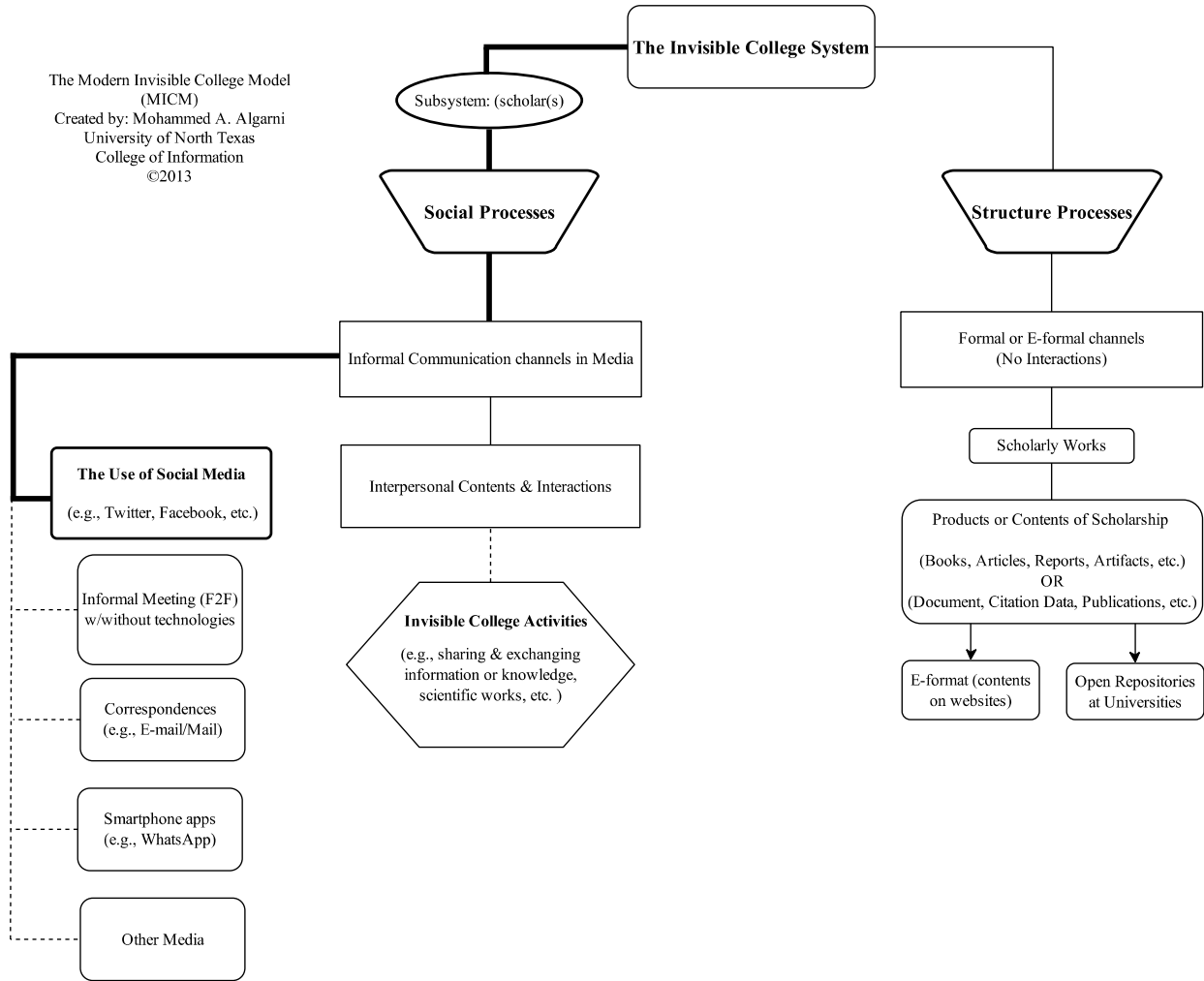


Figure 2. The modern invisible college (MICM).

The Modern Invisible College Model (MICM)
 Created by: Mohammed A. Algarni
 University of North Texas
 College of Information
 ©2013

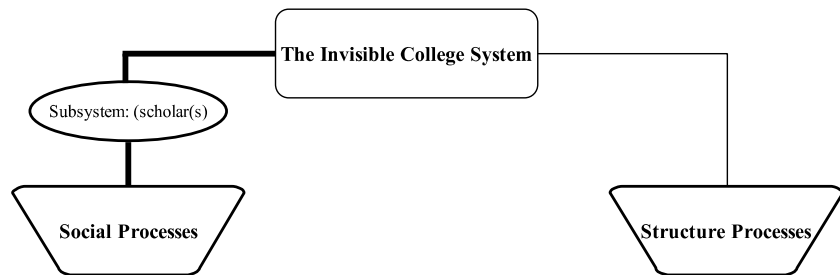


Figure 3. The modern invisible college: Social processes vs. structural processes.

Both the social processes and the structural processes play particular roles in the modern invisible college. Lievrouw (1989) observed that a common problem in the study of science in general is that it tends to focus on the product (e.g., artifacts and published documents) as a means of understanding scientific discourses or social processes and not on the social processes themselves. This problem is also reflected in the invisible college concept. For example, the aim of the bibliometric technique is citation analysis based on published literature. This is typically used by researchers as a statistical method of measuring scholarly communication in many different disciplines.

In Figure 4, the structural processes are elucidated as consisting of formal and e-formal (i.e., defined electronic) channels that facilitate dissemination and retrieval of products and contents (e.g., publications, bibliometrics, and e-formats such as websites and blogs).

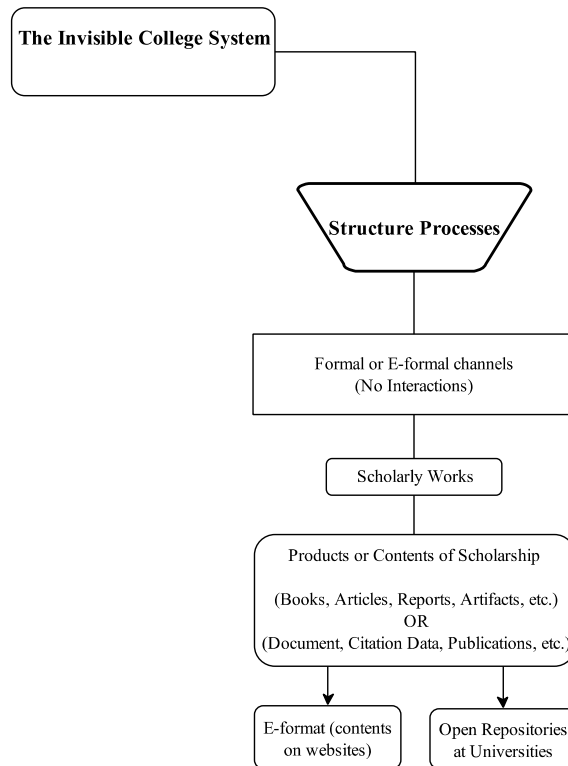


Figure 4. The modern invisible college: Structural processes.

Bibliometrics has been defined in various ways over the last 45 years. Pritchard (1969) defined it as “the application of mathematics and statistical methods to books and other media of communication” (p. 349). Broadus (1987) more recently defined it as “the quantitative study of physical published units, or of bibliographic units, or of surrogates of either” (p. 376). Lievrouw (1989) pointed out that bibliometrics is used chiefly for the purpose of studying the growth and dissemination of scientific literature. And, while Lievrouw thinks bibliometric analyses of the “media of communication” have positively influenced the study of scientific communication it should also encompass “...more direct observation of the communication behavior” (p. 616). While bibliometrics presents an interesting and well-documented research area, it is not the focus of this present study.

Social Processes

The social processes of communication between scholars make for a captivating and relatively original area of investigation, as opposed to the structures of scholarly relationships, which have been studied by many researchers. Our understanding of scholarly interactions will benefit from incorporating a fundamental examination of the discourse, behavior, and research methods of communication that lead up to the product phase (Lievrouw, 1989, p. 616).

Lievrouw and Carley (1990) defined the communication process as “any activity or behavior that facilitates the construction and sharing of meaning among individuals, that they consider to be the most useful or appropriate in a given situation” (p. 459).

Social processes at the stage of interpersonal contact and interaction tend to promote the activities of sharing and exchanging knowledge and ideas between scholars by accelerating communication processes; a study of these processes can facilitate understanding of social behavior. Informal communication networks have different ways of establishing relationships

between scholars. For instance, relationships may originate at social and intellectual gatherings such as conferences or social events, or at any other type of arrangement in which two or more people assemble and are free to discuss and share knowledge (Reid, 2007, p. 144).

The model shown in Figure 5, taken from Lievrouw and Carley's 1990 study, consists of economic and technological elements. These authors considered the model to be an open system that includes internal and external elements. The element of their model of significance for the present study is the "communication processes" element, which facilitates understanding of the proposed model. For instance, it should be understood that an individual changes over time and that, as perceptions of his or her work and the field in general change, different modes and processes of communication will be implemented (Lievrouw & Carley, 1990, p. 466).

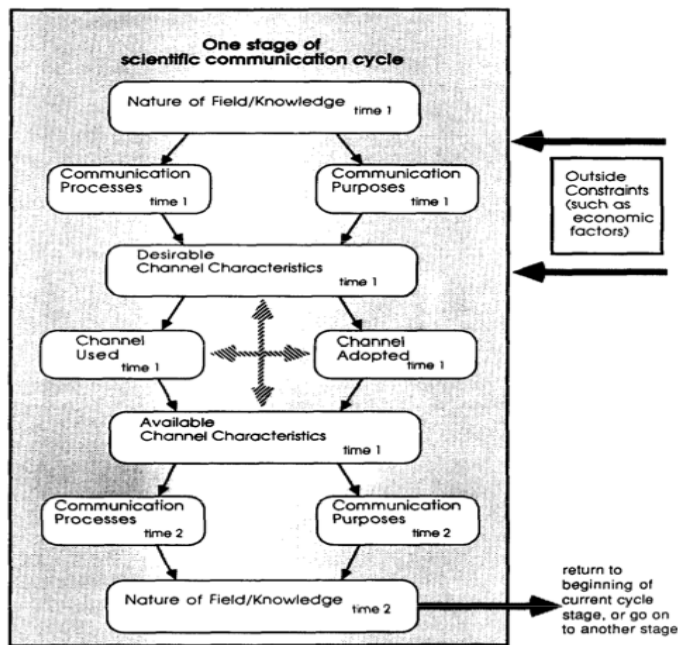


Figure 5. Factors affecting communication channel choices in science (taken from Lievrouw and Carley, 1990, p. 466).

Lievrouw and Carley's model indicates that the communication purposes identified by the scholar at a particular time (denoted as Time 1) will affect the type of channel selected for communication. In turn, the availability of a channel makes it more appealing. The stages of "channel used" and "channel adopted" illustrate the relationship between these two options of use and adoption. The model's communication processes element indicates that the scholar may use a certain communication channel depending on the scholar's intentions, time, and the availability of communication channels. In the present study, the concept of an informal communication channel is used to facilitate understanding of the application of social processes.

Informal Communication Channels in Media

In the process of interpreting the informal communication channel, Lievrouw (1998) raised an important argument. She considered Crane's (1979) usage of "informal" communication as one scientist's view of communication behavior based on indirect observation of actual scientific discourse (p. 619). Lievrouw (1998) identified three problems of Crane's study: (1) the definition of the invisible college concept is unclear; (2) the activities of invisible college members are unclear or unstated; and (3) there is an absence of real information about informal communication channels (p. 466).

Crane focused more on the use of formal communication channels among scholars (i.e., channels that produce documents). Lievrouw noted that other researchers such as Chubin (1983, 1985) focused on the structure of networks among and between scientists, institutions and documents, but failed to acknowledge communication behavior or actual discourse within the structures. Crawford (1971) indicated that informal communication can be defined as communication between individuals based on expanding knowledge, conducting research, and exchanging ideas (p. 301). Lievrouw (1998) added that, by this definition, publications,

presentations on scientific findings, and the presentation of papers at conferences or other meetings or gatherings may be included as examples of informal communication (p. 620). Obviously, Crawford's argument is very far from the main point of informal communication channels. In her critique of Crawford, Lievrouw (1998) further emphasized that Crawford viewed communication as a product of channels of communication and supporting social organizations, rather than the act or behavior of communication itself. Additionally, the measurement of informal communication as documented by Crawford was sociometric, in that Crawford asked the scholars to identify anyone whom they had contacted three or more times during the year regarding work or research. As Lievrouw pointed out, from the perspective of communicative behavior Crawford's contact criteria cannot be reliable, since the context and content of these communicative contacts remain unspecified. Crawford focused on frequency rather than substance and, consequently, illuminated only the structure rather than the processes of communication (Lievrouw, 1998, p. 620).

Faibisoff and Ely (1976) indicated that scientists often prefer to use informal communication channels for several reasons (p. 10). Information received from colleagues in this way is specific and timely, it can be obtained conveniently, and it is current, as opposed to printed works, which are delayed in reaching the masses due to the processes of writing and publication. Garvey and Griffith (1967) stated that informal communication allows for rapid exchanges of information during which scientists can determine whether or not they have identified an individual with similar concerns and interests, or who is working with the same set of scholarly information (p. 1013). Lievrouw and Carley (1990) indicated that scientific communication is the foundation for developing and building on ideas and concepts, thereby leading to scientific successes and breakthroughs (p. 458).

Communication between organizations is often controlled, limited, and made difficult because of communication systems. Faibisoff and Ely (1976) suggested that this may be a reason why invisible colleges are more prevalent in the science community than in engineering; they stated that engineers tend to use information sources available within their own organization, whereas research scientists rely more heavily on outside sources for information and knowledge (p. 7).

Moreover, it has been determined that academic and research-based information is necessary for scientists and social scientists, but not for applied workers. Garvey and Griffith (1967) stated that informal channels of communication allow for flexibility in discourse so that the scientist may direct the conversation toward specific information. This evidence suggests why academics and researchers within the invisible colleges prefer to communicate outside their organizations in order to seek and share information and knowledge. In contrast to the information sources preferred by research scientists, personal contacts are the most preferred source of information among applied science practitioners (Zuccala, 2004, p. 20).

The literature shows that managers spend much of their time in networking and interpersonal contact (Kotter, 1982; Luthans, 1988), communicating orally when they need to acquire desired information (Choo & Auster, 1993). Faibisoff and Ely (1976) confirmed, based on the previous studies that they reviewed, that professionals and researchers communicate with their peers in order to acquire immediate information (p. 10).

As noted previously, “Communication is the essence of science” (Garvey, 1979, p. ix), and it is abundantly clear that science entails social activity (e.g., in the communication of research results). Consequently, communication essentially occurs informally within the invisible college and within a specific network for the purpose of sharing and exchanging

scientific information and knowledge; this exchange is classified as scientific communication, whereas the process of communication within the invisible college is considered as social processes (see Figure 6).

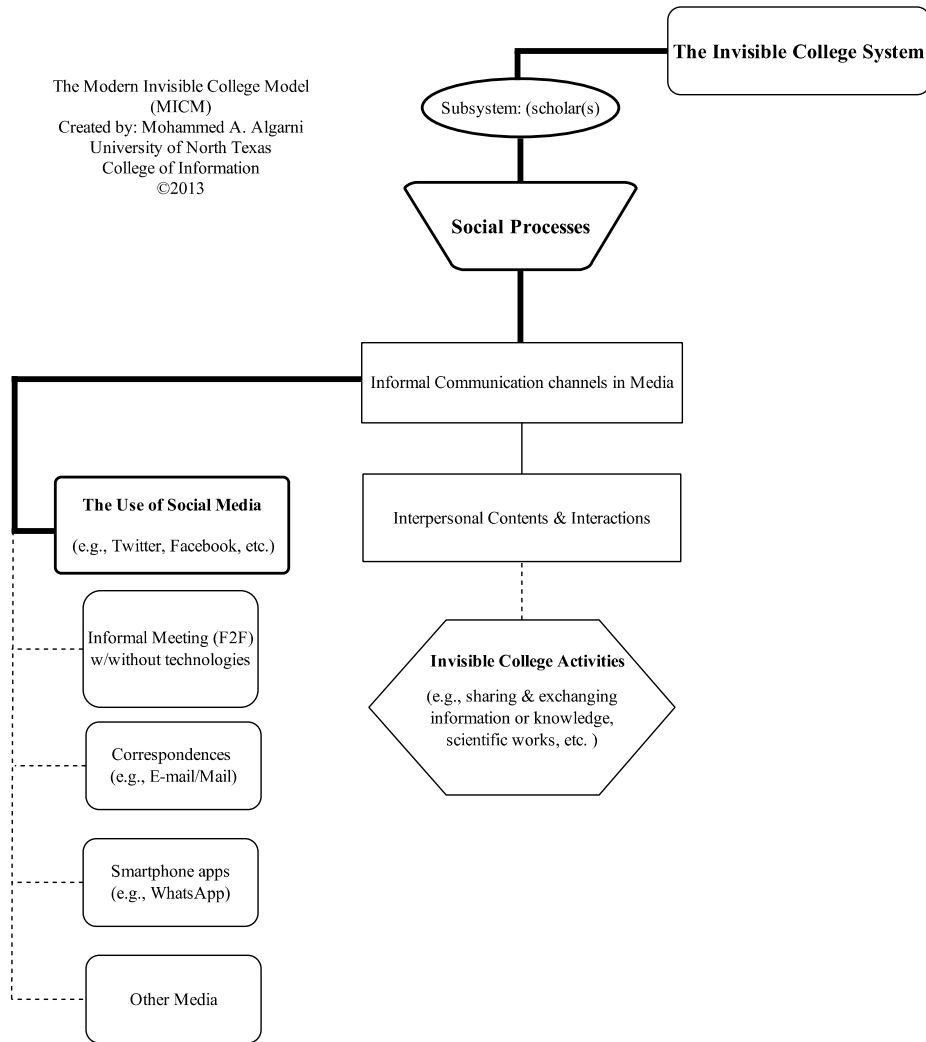


Figure 6. The modern invisible college: Social processes.

Scientific Communication: The Invisible College's Activities

Lievrouw (1989) stated that the foundation of any scholarly endeavor is communication. In fact, without communication there is no science. As mentioned earlier, many researchers have used the form or number of publications (e.g., books, journal articles, artifacts, or bibliometrics) as assessment tools to study the growth of the body of scientific literature and reflect the

evolution of scholarly communication and research (Borgman, 1990; Crane, 1972; Lievrouw, 1989; Price, 1963). However, this study focused on the phenomenon of scientific communication from the perspective of scholars.

The underlying, daily strength of scientific communication lies in the communicative interaction that takes place between scholars via informal channels, such as one or more channels of the new social media (see Figure 7). Garvey and Griffith (1972) explained the concept of informal communication as a way of acquiring or transmitting the most important bits of information from a greater body of scientific work. The users of informal communication are aware that information obtained informally will not be in its polished and publishable state; today, those transmitting information informally are aware that their electronic recipients have the knowledge to interpret such colloquial or abbreviated information appropriately.

Paisley (1968) pointed out that the main benefit of the invisible college is immediate and direct access to a relatively large body of scientists; however, this comes at the cost of the exchange of formal information in the form of actual meetings and in-person collaborative works (p. 5).

Various researchers have sought to explain the interpretive approaches that have been applied to scientific communication among scholars. For instance, Borgman (1990) noted the recent interest in scholarly communication and in the application of bibliometrics. Borgman defined scholarly communication as the way in which scholars—regardless of their field—use and distribute information through both formal and informal communication channels. Bibliometrics, on the other hand, is the statistical and mathematical application methodology used to analyze means of communication such as books and media. Borgman's argument contributes three significant points to this study. First, past researchers misinterpreted the real

channels of communication among scholars. For example, some failed to note the extent to which they use both formal and informal channels for scientific communication. Second, Borgman (1990) verified that scholarly communication is the study of the ways in which scholars use formal and informal channels to use, acquire, or disseminate information (p. 10). Third, Borgman's showed that most previous studies have focused on bibliometric, statistical analysis of scholars' works. As many researchers have failed to differentiate between formal and informal communication channels, the present study emphasizes the need to examine closely the actual use of communication channels for scientific communication between scholars, rather than relying on bibliometrics and similar tools to measure scholarly communication.

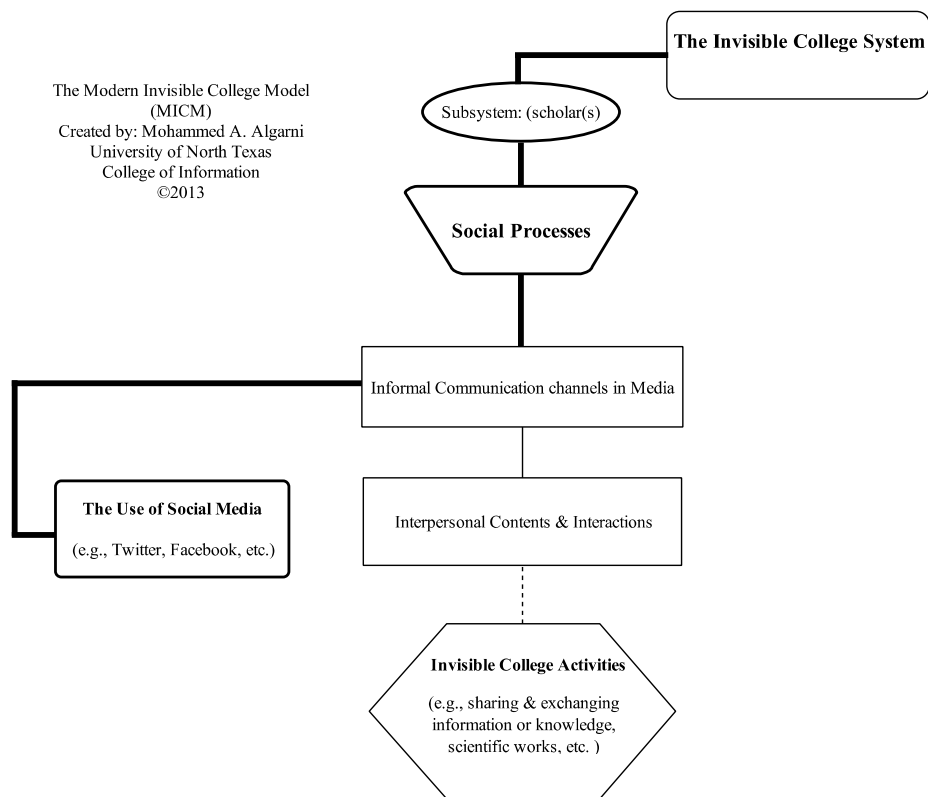


Figure 7. The modern invisible college: Social processes that focus on social media.

Modern technology has radically changed the processes of scientific communication, greatly affecting scholars' communicative activities with their colleagues (see the interpersonal

interaction aspect of Figure 7). Borgman (1993) emphasized the importance of electronic communication for its ability to enhance discourse and amplify the interactivity of scholarship (p. 241). However, her main point was that electronic informal communication channels such as new social media promote scholarly discourse and interactivity. Accordingly, due to fast and easily accessible communication technology, scholars can expand and enhance their communications with members of the invisible college around the world. Today, the invisible college makes possible the discussion of academic issues online with peers who are thousands of miles away. As long as technology advances, scientific communication will similarly continue to advance. Borgman (1993) believed that scholars would embrace the electronic communication environment because it facilitates rapid use and exchange of information between scholars and therefore, expands the concept of the invisible college.

Information and Knowledge Sharing

Over the past decade, academic researchers from a variety of disciplines have focused on information and knowledge sharing and have contributed to further understanding of this issue, particularly within the economic, healthcare, and public sectors (Chong, 2003; Cummings, 2004; Lesser & Storck, 2001; Marouf, 2007). However, few studies have examined the ways in which individuals with differing experiences and skills and from different schools around the world use interactive social media to share knowledge with others (Foregger, 2009; Warnakula & Manickam, 2010). Recent studies (Azudin, Ismail, & Taherali, 2009; Oyekan, 2007) have focused on studying knowledge sharing from the perspective of groups in industry, healthcare, or other private and public sectors, whereas other studies investigate the issue from the perspective of individuals. However, knowledge sharing usually occurs between individuals and through specific channels that facilitate the exchange between user and recipient (Kwok & Gao, 2006).

The concept of knowledge sharing has been used in many disciplines, and its definition depends on the nature of the study and the main purpose of knowledge sharing. The present study, which focuses on knowledge-sharing activities among scholars, follows Lee's (2001) definition of knowledge sharing as any exchange or distribution of information between groups or individuals. Similarly, Ipe (2003) stated that "knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood, absorbed, and used by other individuals" (p. 341). Therefore, how knowledge is shared constitutes an important variable in the study of the invisible college. Accordingly, this paper attempts to investigate the perceptions of scholars as they informally share or exchange information and knowledge. This focus leads us to an important aspect of the communication process: the use of social media by scholars for scientific communication.

The importance of knowledge sharing has become even more evident with the rise of social media, as these media have an effect on individuals' behavior by bringing together knowledge sharers from different disciplines with varied experiences and skills. Knowledge sharing in the academic institution faces some specific challenges, such as education policy restrictions (e.g., requirements to use formal channels, security issues) that reduce the communication channels between individuals (Helou & Rahim, 2011; Hew, 2011; Veletsianos, 2012). In contrast, Ipe (2003) emphasized that "more knowledge is shared informally than through formal channels, and much of the process is dependent on the culture of the work environment" (p. 355).

Talja (2002) asserted that traditional means of distinguishing and documenting the processes of information sharing may not be accurate because they fail to take actual practices

into consideration. Instead, focus has been placed on the selection or preference of certain sources and channels for information retrieval (p. 144).

Paisley (1968) noted that the scientists within an invisible college are electronically present while physically residing in different places all over the globe (p. 5). In the invisible college, their locations are connected and their statuses are equal. In contrast, in a formal organization, such as a university or research facility, the scientists are physically present and represented by titles and status levels. The formal organization may enable or inhibit the scientist's access to information channels (p. 13).

The Use of Social Media

In recent years, the development of efficient social media has received considerable attention in various areas of research. The wide use of popular social media enterprises such as Twitter and Facebook demonstrates the importance of this technology and the ways in which social media have changed the means of communication. Social media have also become one of the most attractive channels within the scientific community for transfer of scientific knowledge or work.

According to Internet World Stats (2013), the "Internet has become the universal source of information for millions of people, at home, at school, and at work [and] in the social web people have found a new way to communicate (para. 2)." Goodrum et al. (2001) confirmed that the Internet "is revolutionizing the entire scholarly communication process and changing the way that researchers exchange information" (p. 662). Goodrum et al. noted that many scholars were already (by 2001) converting their older documents to digital formats for greater dissemination via the Internet. Wagner (2008) stated that today's scientists and engineers have access to more

data than ever before. Ease of access via the Internet makes it possible for users to communicate directly for the purpose of exchanging and improving ideas and data, thereby advancing science.

New technologies have provided an unprecedented dimension to the concept of the invisible college in the field of scientific communication. The invisible college has not changed in essence—it is still based on personal contact—but the means by which to make such contact have changed dramatically. Veletsianos (2012) confirmed that interest in social media research has been greatly influenced by youth; as of yet, the use of social networks and participation in social media for scientific purposes by higher education faculty has not been fully explored (p. 3). Moreover, Veletsianos emphasized the relative lack of understanding of scholarly practices in social networks. He posed the question, “What do scholars do in social networks, and what do their naturalistic practices reveal about scholarly practice?” (p. 4). He stated that, while one may make assumptions based on what is made public via social media, Twitter reveals only small amounts of information and leaves no existing documentation or evidence of scientific activities outside a particular forum. Veletsianos (2012) suggested that a study of scientific practices as a whole would shed useful light on online scholarly communicative behavior (p. 4). He noted that scholars prefer to share their professional investigations, ideas, and queries with likeminded individuals, such as other researchers.

Warnakula and Manickam’s (2010) study indicated that many users are still limited to the traditional uses of social media; for instance, most participants use social media for making and maintaining connections with personal friends. Priem and Hemminger (2010) found that many scholars have become active participants in the new social media and predicted that scholars’ use of social media would continue to increase.

Certain types of social media are more frequently used by scholars for the purposes of informal communication and exchange of information, such as blogs, micro-blogging sites, and wikis (Gruzd & Staves, 2011). Research on the use of social media by scholars is negligible, and relatively few studies have examined faculty members' use of social media for professional purposes (Greenhow 2009; Veletsianos 2012; Veletsianos & Kimmons 2012; Veletsianos et al. 2013). Social media, as illustrated in Figure 7, are informal channels of communication that facilitate interpersonal interaction between scholars. Previous studies report that scholars usually use personal contact for informal communication and information exchange. Communication among scholars usually takes place in direct and informal exchanges, typically between individuals or within a small group (Lievrouw & Carley, 1990, p. 461). In this case, interaction among scholars does not require that they be geographically near one another, as the new technologies remove geographic barriers. Social media and other communication channels facilitate communication and personal interaction among scholars, either nationally or globally. In recent years, the use of social media has increased globally (Chen & Bryer, 2012).

To understand the major changes taking place in the processes of scientific communication, it is necessary to understand why invisible colleges are engaging in social media and how they interact and communicate informally. Currently, it seems that invisible colleges in various disciplines prefer to use modern communication channels for informal communication. An examination of the social processes in which scholars engage can reveal what informal communication channels are used most frequently.

As new technologies become more common among individuals and societies, scholars can be expected to use multiple informal communication channels, such as social media, because scholars are considered a part of the social system. Although many studies have focused on

informal communication channels and their users, they have not provided clear evidence regarding the appropriate informal communication channels that scholars prefer for scientific communication. For instance, in most of the past research on the use of informal communication channels, the researchers have identified specific channels of interest (e.g., Twitter, Facebook), which may affect the credibility of their study results. It is difficult to predict specific channel preferences of individuals without having extensive prior knowledge before conducting the research. Lievrouw and Carley (1990) indicated that scientists choose certain channels for informal communication based on perceptions of relevance. Additionally, they encouraged researchers to examine the factors that affect the use of communication channels. There are now hundreds of informal communication channels—either technological or traditional.

Although traditional communication channels are still significant and useful in reaching a target audience, online communication channels, such as social media, e-forums, blogs, and other technologically based channels, now play a significant role in the scientific community. It is essential to study and understand the types of informal communication technologies used by scholars for scientific communication; this knowledge will contribute to a greater understanding of the invisible college phenomenon. Wagner (2008) pointed out that global science is essentially an invisible college, in that both concepts are made up of participants and communication; the type of communication used is especially important to the identification of the invisible college. In this present study, informal communication channels supported by technology—specifically social media—are the major focus in order to determine the most frequent channels used by scholars for scientific communication.

Tyson (2010) indicated that new media are part of the Web 2.0 phenomenon, which he defined as “the second generation of Web-based communities and services that created online

social media” (p. 161). Tyson also stated that the primary value of social media is that they allow individuals to reach broad audiences and give individuals greater control in conveying their message. Tyson said that scholars have rapidly adopted the use of social media; for instance, he stressed that many scholars have social media links available on their profiles on college and university websites. In addition, the continued growth of social media seems to be virtually unlimited, considering the observation by Intel founder Gordon Moore that the power of computing doubles every 2 years.

Accessing online social media does not require great experience or skills. For instance, Twitter enables individuals to be members of its community by simply opening an account and using its services. Most of the services provided by online social media enable scholars to take further actions, such as embedding hyperlinks to specific websites, journals, books, interesting topics, conferences, and more, which open broader communication within the scientific community. In addition, social media add new features and services that facilitate communication to certain target audiences (Tyson, 2010). For example, Twitter and Facebook allow users to receive notifications (by e-mail or text message) when another user posts a comment or submits a friend request. In the case of Twitter, users “follow” other users, groups or organizations, and have “followers.” Notifications inform a user of any activity associated with his or her account; these notifications can be enabled or disabled in the user’s account settings. Users may enable notifications for any number of activities related to their account. In addition, certain applications allow users to update many accounts simultaneously for faster and greater dissemination of information (Tyson, 2010).

The present study builds on the findings of earlier research on informal communication channels (Moran, Seaman, & Tinti-Kane, 2011; Singh & Gill, 2011), which demonstrated that social media have fundamentally changed informal communication among scholars.

“Social media” is a broad term used to denote numerous informal communication channels. This study defines social media as a variety of informal online channels, sites, platforms, and mobile phone applications that provide services to individuals or groups for various activities such as exchanging and sharing information and knowledge in textual, pictorial, audio, or video formats, as well as other multimedia communications that reflect social networks and relationships among individuals who share similar interests and activities. Social media often involve grouping of specific individuals, as in the case of the invisible college. Examples of social media tools include, but are not limited to, social networking sites such as Facebook, MySpace, and LinkedIn; blogs; micro-blogs such as Twitter and Yammer; virtual worlds such as Second Life; and sites for sharing documents, videos, and audio content such as YouTube and Slideshare. Figure 8 illustrates, through a timeline, the history of the new social media since 2000.

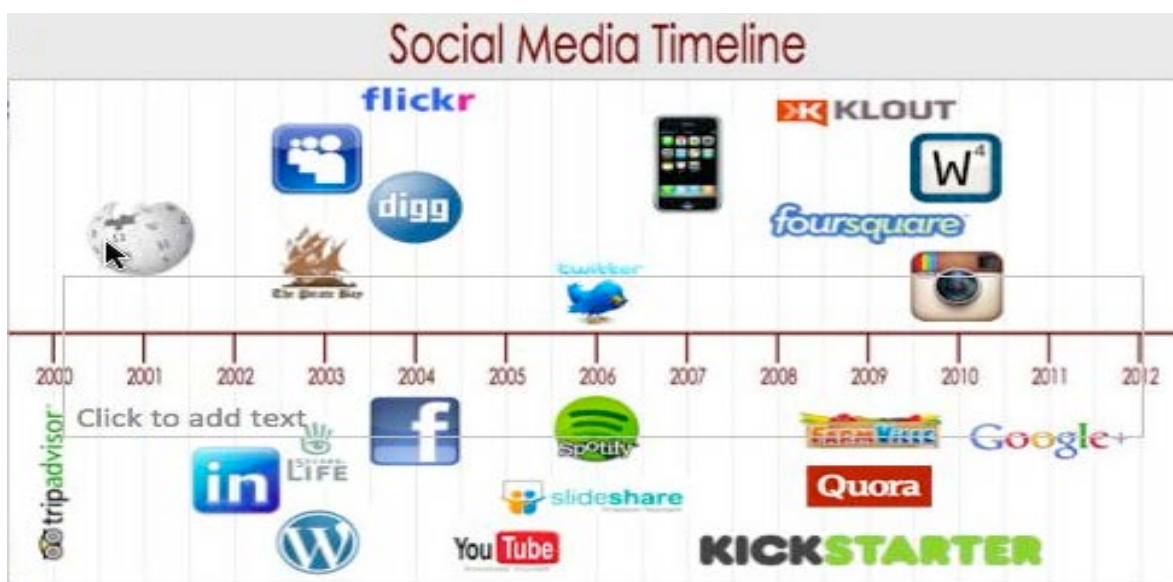


Figure 8. Social media timeline (taken from <http://www.digital-rights.net/?cat=8>).

The new online social media have the potential to foster greater interactions among scholars. Singh and Gill (2011) defined social media as a new design for “e-communication to the masses for two way communication and interactions of all rounds of information seamlessly” (p. 232). However, their definition does not include the main role (e.g., informal communication) of the new social media. Accordingly, this present study defines the use of social media for scholars as a set of activities such as sharing information, knowledge, insights, and common interests, establishing new relationships with other scholars, and exchanging ideas and research works or sources, that may facilitate communication practices in scientific fields.

Singh and Gill (2011) stated that social media are reshaping electronic communication. Many studies have indicated that social media use is becoming more prevalent in institutions around the world (Hamid et al., 2011; Parveen, 2011); social media applications have already been accepted by individuals as informal channels by which to communicate, socialize, and collaborate informally (Singh & Gill, 2011; Zakaria, Watson, & Edwards, 2010). Although most prior research on the use of social media has focused on a handful of specific sites, such as social networking sites, there are hundreds of social media tools that reach millions of individuals for various purposes (Shafique, Anwar, & Bushra. 2010; Singh & Gill, 2011; Zakaria et al., 2010). Thus, social media provide a significant service to scholars in facilitating informal scientific communication (Bik & Goldstein, 2013; Cruz and Jamias , 2013; Eperen & Marincola, 2011; Gu & Widen-Wulff, 2011; Gruzd et al., 2012; Rowlands, Nicholas, Russell, Canty, & Watkinson, 2011; Veletsianos & Kimmons, 2013). Gruzd et al. (2012) found that scholars most often cite as social media’s greatest asset their “ability to facilitate collaboration and communication between peers (especially internationally and across disciplinary boundaries) and with people outside

academia.” (p. 2341). Cruz and Jamias (2013) described social media as “online technologies and practices that people use to share opinions, insights, experiences, and perspectives” (p. 3).

A recent study of scholars’ use of social media for research purposes provided a framework consisting of the socio-demographic profile of scholars and their perception of social media, as shown in Figure 9 (Cruz & Jamias, 2013). This framework could be even more helpful if it included additional elements such as informal communication channels or communication processes among scholars.

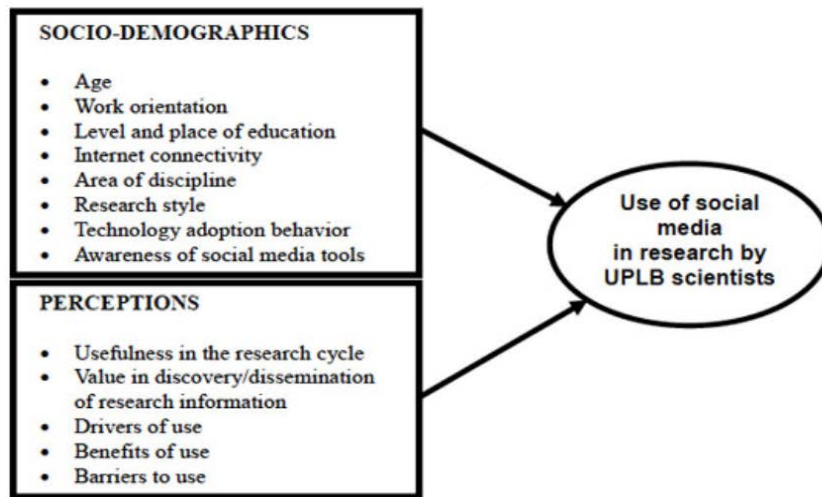


Figure 9. Conceptual framework of scholars' use of social media (taken from Cruz and Jamias, 2013, p. 5).

Based on the above framework, the present study investigated the influence of age in a targeted group of scholars who use social media for scientific communication. The data related to scholars’ age in Singh and Gill’s (2011) study indicated that, among respondents who were most likely to use social media, 90% were between the ages of 20-30, 7.5% were between the ages of 30-40, and only 2.5% were in the 40-50 age group. Rowlands et al. (2011) reported that social media use for all ages will most likely become roughly equal as time goes on and social media become accepted as a normal mode of communication.

Cruz and Jamias (2013) noted that various social media are useful tools for communicating research results among scholars. Cruz's and Jamias' study also revealed that various disciplines, such as organizational public relations, health and crisis communication, and social mobilization, use social media more heavily as a communication tool. Cruz and Jamias (2013) found that scientific use of social media for communication and scholarly purposes, such as collaboration and research, have resulted in a further increase in the pace of scientific investigation. Similarly, Correa et al. (2010) stressed that social media serve as a platform for connecting and networking in rapid and sometimes immediate interactions. Sajithra and Patil (2013) considered social media to be "an extension and explosion of traditional word of mouth networks" (p. 73). For instance, social media has been widely accepted as a scholarly tool for the purpose of connecting with other scholars to work on collaborative projects and to share, exchange, and acquire knowledge (Howard, 2011, p. 1).

Moran et al. (2011) conducted a survey on faculty from all disciplines of higher education in the U.S. and found that more than 90% of faculty used social media either for professional purposes or in their classes, or both. Almost every user of social media used at least one social media site; more specifically, Moran et al. (2011, p. 9) indicated that 78% of all faculty reported using at least one social media site in support of their professional career activities. In terms of frequency of use, 60% used at least one social media site at least once a month, and respondents were evenly divided among those who used social media monthly, weekly, and daily (Moran et al., 2011, p. 7). The study showed that new faculty use social media more frequently than faculty members who have more than 20 years of teaching experience. However, the study did not directly examine forms of communication among scholars.

Singh and Gill (2011) examined the use of social networking sites by research scholars. Based on the results of a survey of 40 professors with doctoral degrees at Guru Nanak Dev University, they determined that social media had played a significant role in the development of scientific works. The majority of respondents used social media in their research, and Facebook was the preferred social media tool among research scholars. Singh and Gill, in their interpretation of the data, focused on respondents' gender and age, the common uses of social media among scholars, the type of devices used to access social media, the purpose of using social media, the duration of use, the nature of membership on social media, the number of friends on social media, and the obstacles that the scholars faced while accessing social media.

Many studies have revealed the use of social media among scholars in various countries, but few have been carried out in the context of developing countries such as Saudi Arabia.

Social Media and Uses and Gratifications

Overview of Social Media and the Uses and Gratifications Theory

Haythornthwaite and Wellman (1998) argued that scholars' information-sharing behavior is affected more by the differing types of media used than by the individual attributes of the actors themselves. Additionally, the study demonstrated that the channel of communication chosen by a scholar depends on the type of information or knowledge to be shared or acquired.

Walsh, Kucker, Maloney, and Gabbay (2000), in a study on scholars' use of the Internet, found that knowledge sharing is facilitated by the Internet and other technologies (e.g., social media) to support collaboration and enhance relationships among scholars.

While there is a wealth of literature on uses and gratifications theory (Bryant & Zillmann, 1994; Helou & Rahim, 2011; Livingstone, 1997; Newhagen & Rafaeli, 1996; Papacharissi, 2009), studies that focus on social media (Foregger, 2009; Urista, Dong, & Day, 2009;

Warnakula & Manickam, 2010), or scholars (Abdulhamid & Salim, 2010) are limited. Most research on mass communication, information science, and higher education has focused on the use of social media by students (Agarwal & Mital, 2009; Urista, Dong, & Day, 2009) rather than by scholars. Therefore, there is a need for further investigation of social media use by scholars (Hew, 2011, p. 676).

This study represents an attempt to apply uses and gratifications theory as well as certain models associated with informal communication channels (e.g., social media) to issues in the invisible college. This study also proposes a model for the modern invisible college that may aid future research on social and structural processes of communication. Clarification of the relationship between social and structural processes may heighten our understanding of the mechanisms of the modern invisible college.

Uses and Gratifications Theory

Uses and gratifications theory was originally presented by Elihu Katz during the 1970s, resulting in a change of focus in mass media research from production to audience. Past studies have applied this theory to various media, including radio shows, television news, the Internet, and (most recently) cell phone and social media applications (Katz, Blumler & Gurevitch, 1974; Papacharissi, 2009; Rosengren, 1974; Rubin, 1994; Ruggiero, 2000). Papacharissi (2009) defined uses and gratifications theory as a “psychological communication perspective that examines how individuals use mass media” (p. 137).

Uses and gratifications theory makes clear the relationship between the needs and interests of a certain audience and the effects of a specified media (Katz et al., 1974). According to Newhagen and Rafaeli (1996), the theory provides a framework for understanding a new form

of media (e.g., social media) since it can reveal why individuals tend to use a certain kind of media.

Rubin (1994) stated that uses and gratifications theory consists of the following five assumptions:

(a) communication behavior, including media selection and use, is goal-directed, purposive, and motivated; (b) people take the initiative in selecting and using communication vehicles to satisfy felt needs or desires; (c) a host of social and psychological factors mediate people's communication behavior; (d) media compete with other forms of communication (i.e., functional alternatives) for selection, attention, and use to gratify our needs or wants; and (e) people are typically more influential than the media in the relationship, but not always. (p. 420)

Uses and gratifications researchers are concerned with the potential of media in the hands of the people, or, in Katz's words, "Ask not what the media can do to the people, but what the people can do with the media" (Katz et al., 1974, p. 21). The theory is considered a psychological and sociological theory of the human personality that focuses on the functions of the media for individuals.

Katz, Blumler, and Gurevitch (1974) provided three basic objectives of the uses and gratifications theory: (1) to explain how individuals use the mass media to gratify their needs, (2) to understand the motives behind individuals use of specific media, and (3) to identify the positive and the negative effects resulting from individuals' media use (p. 20).

Hence, uses and gratifications theory is more focused on individuals, whose active participation empowers the media to provide messages that can fulfill their interests and needs. According to Katz et al. (1974), it focuses on "(1) the social and psychological origins of (2) needs which generate (3) expectations of (4) the mass media or other sources, which lead to (5) differential patterns of media exposure (or engagement in other activities), resulting in (6) need gratifications and (7) other consequences, perhaps mostly unintended ones" (p. 20).

Papacharissi (2009) stated that uses and gratifications theory has been employed to promote understanding of various media uses and consequences, including, for instance, surfing the Internet. Papacharissi also pointed out that uses and gratifications theory is significant and relevant because of its applicability to a number of media contexts.

In general, uses and gratifications theory offers several insights that might apply to the use of specific social media. For example, if individuals perceive social media as incapable of constantly meeting their particular needs or providing related information or knowledge, they are less likely to become dependent on it as a primary means of gratification. Chatman (1991) captured this idea when she acknowledges that people do not passively engage in social media; rather, they are actors with a motive in the form of goals, wants, or needs.

Criticism of Uses and Gratifications Theory

According to Ruggiero (2000), mass communication scholars overlooked uses and gratifications theory for several decades, but the inception and escalation of communication technology may have saved it from extinction. Moreover, Ruggiero stated that the incessant evolution of technology provides consumers with constantly changing media options, making consumer motivation and satisfaction are ever more significant in analysis of media audiences. He also indicated that uses and gratifications theory has served throughout its history as an innovative theoretical approach to mass communication media in their early stages, including the Internet today as well as the inception of radio, and television. Other studies have applied uses and gratifications theory to investigate use of the World Wide Web in general (Charney & Greenberg, 2002; LaRose & Eastin, 2004).

Livingstone (1997) and Rubin (1994) criticized uses and gratifications theory as too individualistic, although indirect results of particular studies have the potential to be confirmed through “consistent findings across samples, media, and cultures” (Rubin, 1994, p. 423).

The dominating question driving the inception of uses and gratifications theory was whether the audience used a certain type of media to fulfill its needs or if it relied on a multitude of methods. Uses and gratifications theory has revealed that individuals use various media for different purposes, so that one individual may use the same or different media for different reasons, events, or occasions (Katz et al., 1974).

Despite the criticisms of its individualistic approach, uses and gratifications theory should nonetheless be considered a fruitful perspective for researchers. Critics have acknowledged that uses and gratifications theory has been integrated with other theories due to its usefulness and relevance across many fields. Moreover, the debate over active versus passive use of media has continued, thanks in large part to Katz. However, Livingstone (1997) argued that this debate is no longer relevant and should be put aside in order to advance our understanding of media use.

Using Social Media and Use and Gratifications Theory

Because the modern social media phenomenon is so new, few studies have addressed it through the lens of uses and gratifications theory, as the present study seeks to do.

Lull (1995) proposed that the studying how and why individuals use various forms of media may aid researchers by offering evidence for understanding their exact needs, where they are initiated, and how they are satisfied. Decades of uses and gratifications theory research have emphasized the strong connections between media selection and the gratifications that users seek (Helou & Rahim, 2011; Raacke & Bonds-Raacke, 2008). Social media have been defined as “virtual places that cater to a specific population in which people of similar interest gather to

communicate, share, and discuss ideas” (Raacke & Bonds-Raacke, 2008, p. 169). Hence, social media allow users to interact and share information and knowledge with populations of people with similar interests.

Regarding competition between online communication channels and traditional media, studies have also found that social media can serve as an alternative to mass media outlets (Owen & Humphrey, 2009). For example, while traditional media (e.g., radio and television news broadcasts) continue to slide in popularity, the audience is expanding for news distributed on social media (Rainie, 2010).

Recent studies have indicated that the most common approach to explaining specific media behavior has been uses and gratifications theory (Owen & Humphrey, 2009; Raacke & Bonds-Raacke, 2008). However, none of these studies have explained individuals’ behavior in using social media or how users themselves determine their needs.

Academic research applying uses and gratifications theory to the use of any social media seems limited; specific application of the theory to how scholars communicate or share knowledge with others via social media has not yet taken place, although several studies have investigated why students use these sites (Agarwal & Mital, 2009; Helou & Rahim, 2011; Hew, 2011; Urista, Dong, & Day, 2009).

CHAPTER 3

METHODOLOGY

This chapter describes the research methods and procedures used for obtaining and analyzing data in this study. Leedy and Ormrod (2001) state that research methodology is the set of processes used for collecting and analyzing data. Mingers (2001) defines research methodology as a “structured set of guidelines or activities to assist in generating valid and reliable research results. It will often consist of various methods or techniques, not all of which need to be used every time” (p. 242).

Research Design

This study was designed to collect data directly from faculty members at the Institute of Public Administration in Saudi Arabia. Participants were asked to discuss their perception of the use of social media for the purpose of scientific communications. On the basis of the purpose of the study, a quantitative research design was used as a descriptive study. The quantitative research defined by Babbie (2009) as “the numerical representation and manipulation of observations for the purpose of describing and explaining the phenomena that those observations reflect” (p. 422). Thus, the advantage of a quantitative approach is that it is possible to measure the reactions of a large number of people to a limited set of questions, thereby facilitating comparison and statistical analysis. Gay (1996) points out “the descriptive study is concerned with the assessment of attitudes, opinions, demographic information, conditions and procedures” (p. 249).

A survey method (questionnaire) was used in this study because it is an appropriate tool to gather and answer the research questions (Fraenkel & Wallen, 2009). The survey method is considered one of the best techniques to help investigators collect feedback on facts, values,

beliefs, feelings, attitudes, ideas, judgments, and experiences (Sudman & Bradburn, 1982; Taylor-Powell, 1998). To obtain the data required to address the research questions posed in this study, a questionnaire was sent to full-time faculty members who hold Ph.D. degrees at the Institute of Public Administration (IPA) in Riyadh, Saudi Arabia. The following sections describe more thoroughly the research questions, the target population, the instrument (questionnaire), the pilot study, and collection and analysis data.

Research Questions

The following research questions are addressed:

1. To what extent are the scholars at the Institute of Public Administration using social media for scientific communication?
 - a. How do these scholars decide which informal communication channel is appropriate for their communication?
 - b. What social media do scholars use most frequently for scientific communication?
2. Why do scholars use social media for scientific communication?
 - a. To what extent do these scholars perceive social media as useful for scientific communication?
 - b. What factors influence scholars' perceptions of using social media tools for scientific communication?
3. How can uses and gratifications theory explain the use of social media among scholars for scientific communication?

The Institute of Public Administration

The subjects of this study were scholars who have Ph.D. degree or above at the Institute of Public Administration (IPA) in Saudi Arabia. The IPA was established as an independent government body whose headquarters is in Riyadh (IPA, 2013). The IPA plays a major role in raising the performance efficiency of the government and private sectors in various fields of administrative development through the following main activities:

1. Training. Training programs offered by the IPA vary in accordance with the program objectives and the target beneficiaries as follows:
 - a. Various programs equip holders of high-school and university degrees to assume posts in the government and private sectors.
 - b. In-service training programs further develop the abilities and skills of government and private-sector employees and enrich their knowledge in all administrative domains.
 - c. Workshops and forums help upper administrative leaders to improve their skills.
2. Administrative consultation. The IPA provides administrative consultation services to government and quasi-government bodies, to some private institutions in Saudi Arabia and neighboring Gulf countries, and to some Arab organizations. The services are aimed at organizing the work of these organizations, improving their performance, and assisting with specific administrative problems.
3. Administrative studies and research. Through this activity, the IPA promotes organizational thinking and awareness by:

- a. Preparing and encouraging academic research related to administrative subject areas; also by publishing the *Public Administration Journal*, a specialized periodical issued quarterly and containing research studies, and articles in the field of administration and related sciences.
 - b. Holding symposiums, meetings, and conferences to discuss and solve administrative problems.
4. Administrative documentation. One of the IPA's main tasks is to provide and make accessible information sources pertaining to the IPA's own activities, including collecting, classifying, and maintaining administrative government documents.

Participants and Sample

The study population consists entirely of scholars at the Institute of Public Administration in Riyadh, Saudi Arabia, who have Ph.D. degrees or higher. The participants include both females and males at the IPA headquarters and its branches. The participants were asked to identify their academic field from among the 12 majors offered by the IPA in order to produce more accurate and comprehensive results. The IPA was selected for this study because the researcher has access to its faculty and because it has the characteristics of interest to the study. According to the 2013-2014 statistical report of its Department of Development and Scholarship, the IPA has 12 academic fields and ($N = 96$) faculty members with Ph.D. degrees. Consequently, the total population in this study is ($N = 96$) scholars from various academic fields at the IPA. The questionnaire was distributed to scholars in all academic fields at the IPA; 80.2% ($n = 77$) of the surveys were returned completed. Table 1 shows the academic field, number of Ph.D. faculty members, and the number and percentage of responses.

Table 1

Distribution of IPA Faculty Members by Academic Field

Academic Field	Number of Ph.D. Faculty Members	Number of Responses	% Response
Business Administration	8	7	87.5
Computer Science	7	7	100.0
Economics	5	5	100.0
Engineering Management	4	3	75.0
English Language	8	7	87.5
Health Administration	5	4	80.0
Human Resource Management/Education	14	13	92.8
Information Science	2	2	100.0
Law	22	13	59.1
Public Administration	10	9	90.0
Public Relations and Media	3	3	100.0
Statistics	8	4	50.0
Total	96	77	80.20

Source: IPA Statistical Report 2013-2014.

The study outcomes are not generalized other than to the population of scholars at the IPA in Saudi Arabia because the target population of this study is limited. Therefore, the sample includes all full-time faculty members at the IPA. According to Line (1982), a sample is “a limited number of items or people from whom generalisations can be made about the whole number” (p. 31). The central principle of probability sampling is that “a sample will be representative of the population [in this case IPA Scholars] if all members of the population have an equal chance of being selected in the sample” (Babbie, 1998, p. 200).

Instrumentation

This study employs a quantitative method to collect data, and a survey questionnaire technique was used. Baruah (2012) points out that the questionnaire is “the most appropriate method to carry out a survey in order to find out the growing importance and the use of social

media as a tool of communication” (p. 1). Moreover, in a descriptive study, Babbie (2009) states that researchers use the survey method for collecting data (p. 254). Hence, after examining the research, the questionnaire method was used for the present study as an appropriate method. This study’s instrumentation is developed based on surveys conducted in previous studies, such as that of Singh and Gill (2011), with some modifications and the researcher developed most of the survey based on information obtained from the literature review. Moreover, the questionnaires were modified based on feedback received during the pilot test. A short period of time and speed can be “especially valuable at the pilot-testing stage of survey development, where pilot testing and instrument clarification are needed before the final survey can be launched” (Simsek & Veiga, 2001, p.220). Also, Driscoll (2011) states that “one of the keys to creating a successful survey is to keep your survey short and focused” (p. 166). The study respondents were classified according to academic field as identified in Table 1. The survey instrument (see Appendix A) includes a version of a letter from the IPA to scholars, an informed consent, a cover letter explaining the details, purpose and importance of the survey, as well as an assurance of confidentiality and a statement that participation is voluntary. Completion and submission of this letter indicates scholars' willingness to participate in the survey.

The survey instrument consists of four sections. The first section asks scholars about frequency of use of social media for scientific communication purposes. The second section consists of four parts. Part 1 includes a question about technology utilization for accessing social media platforms for communication. This section also allows participants the opportunity to choose types of devices used for accessing social media such as Smartphones, PCs, Laptops, Tablet computers, and others. Part 2 asks participants to rate their utilization of several popular social media for scientific communication. This section utilizes a scale of 5 points: 1 = *Never*, 2

= *Rarely (once a month)*, 3 = *Sometimes (twice a month)*, 4 = *Often (once a week)*, and 5 = *Constantly (once or more a day)*. Part 3 asks participants to indicate the social media tool most frequently used as a channel of scientific communication. Baruah's (2012) study indicates "the most popular websites offering social networking currently are MySpace (started in 2003), LinkedIn (started in 2003), Facebook (started in 2004) and Twitter (started in 2006)" (p. 4). The present study includes additional social media platforms such as MySpace, YouTube, Flickr, Skype, Blogs (weblogs), Google+, Instagram, and forums. Thus, participants were given the opportunity to rate a greater number of social media tools used for scientific communication. Part 4 uses closed questions developed for the purpose of this study. Driscoll (2011) points out that the use of closed questions is an appropriate technique for the advantage of creating a survey. He also defines closed question as a "set of questions that gives a limited amount of choices (yes/no)" (p. 166). Part 4 contains six statements; each statement consists of yes/no questions which were designed to collect information about the decisions of choosing the appropriate informal communication channel. The third section of the questionnaire contains three sections, and each section consists of yes/no questions that were designed to collect information about participants' perceptions of using social media for scientific communication. Part 1 contains ten statements and asks participants about reasons for using social media for scientific communication. Part 2 consists of ten statements and asks the participants about their perceptions of social media as a useful tool for scientific communication. Part 3 contains eight statements and asks the participants about their perceptions of the barriers prevent them from using social media tools for scientific purposes. The fourth section of the questionnaire is designed to collect demographic information regarding gender, age, academic rank, and academic field of study. This section also contains an optional question that gives the

participants the opportunity to add any comments or concerns they want to include. This option provides the opportunity for participants to “say what is really on their minds without being influenced by suggestions from the researcher” (Foddy, 1994, p. 127). Lastly, the researcher distributed 96 surveys to scholars in different academic fields at the IPA. The response rate was 80.2% ($n = 77$) of the total were returned completed.

Validity, Reliability and Pilot Study

For any selected research method, validity and reliability are described as “tools of an essentially positivist epistemology” (Watling, 1995, p. 5 as cited in Simco & Warin, 1997, p. 670). Case (2007) describes validity as “the extent that the measurement procedures accurately reflect the concept a researcher studies” (p. 181). Moreover, Babbie (2009) explains validity as “a term describing a measure that accurately reflects the concept it is intended to measure” (p. 153). In the present study, the validity and reliability of the instruments were checked and tested in different ways. The instrument tool was reviewed by group of experts and arbitrators (Appendix B includes the names of experts and arbitrators), starting with my supervisor, and followed by experts in statistics and questionnaire design. Experts and arbitrators made comments on the contents and the format of the questionnaire. Because the official language in Saudi Arabia is Arabic, the instrument was translated into Arabic from its original English version. To overcome naturally occurring translation problems, the researcher used the “back translation” method, which is considered an effective way to ensure a valid translation. Still, the researcher sent the questionnaire to three professors who are linguists specialized in teaching English as a second language. They were asked to review it in both versions (English and Arabic). They provided feedback for clarity and any confusing items. For reliability, it was important to conduct a pilot study to measure the reliability of the translated version to ensure it

was dependable and consistent (Gatewood & Field, 2001). A pilot study is a test study that is most often performed before collecting the data. It aims to refine and improve the questionnaire. In this case, participants can understand the questions without facing any problems, and give their answers clearly. A pilot study also helps researchers to record their data easily, and reduces the possibility of getting incomplete answers. Generally, the number of participants should be at least ten (Saunders, 2000). The research tool was reviewed by group of experts and arbitrators (See Appendix B has the names of experts and arbitrators) including my supervisor as well as experts in statistics and questionnaire design. Experts and arbitrators made comments on the contents and the format of the questionnaire. The questionnaire was refined, and then ten participants who worked at an institute similar to the IPA were chosen to review the questionnaire. Discussions consisted of comments and feedback about repeated questions, clarity of questions, order of questions, and whether the questions directed the participants toward a specific alternative. All comments from experts, arbitrators, and participants were discussed with my supervisor, and then adjustments were made.

Data Collection Procedures

The study focused on collecting primary data about the research scholars through a structured questionnaire. The researcher gained official permission from the committee members, the Institutional Review Board's (IRB) approval from the University of North Texas, and official permission from Institute of Public Administration (IPA) to conduct research on the IPA's scholars (see Appendix B). The study was conducted during working hours in the winter break at UNT 2013 when few if any of the subjects were on vacation. The researcher spent two weeks to finish the data collection process. The questionnaires were hand-delivered with a cover letter by the researcher to the scholars, in order to complete primary data required for the study.

Hand-delivery of the questionnaire is beneficial, as the researcher may be asked to clarify or answer some questions, or otherwise listen to suggestions raised by the respondents. It was especially important to assure subjects that their identity and any information shared in their responses would be treated with full confidentiality. This procedure was very convenient, given the setup of this study in which every subject was clearly defined, and it permitted an effective follow-up to ensure a high response rate.

Data Analysis

The current study utilized the statistical package for social sciences (SPSS) version 20 for Windows to analyze the collected data. The data was analyzed using statistical analysis and procedures, including descriptive statistics, the number of participants who took the survey, the percentages, frequencies, means, standard deviations analysis, and graphs. However, the statistical tests are provided for descriptive purpose only. Crosstab analyses using Pearson's Chi-Square tests were conducted to analyze whether there were relationships between the categorical independent variables (Field, 2009). The categorical variables for this analysis include:

- Dichotomous variable: use of social media as scientific communication tools (2-level).
- Categorical variables: gender (2-level), age (5-level), academic rank (5-level), and academic field (20-level).

CHAPTER 4

RESULTS

Introduction

This study explored scholars' perceptions of using social media for scientific communication at the Institute of Public Administration (IPA) in Saudi Arabia. This chapter commences by presenting the quantitative results as an appropriate way to analyze the questionnaire data of this study. Frequency and percentage were conducted for each profile. Means and standard deviations were calculated using a point scale. This chapter first provides a profile for the sample, including the response rate and the demographics of respondents.

Sample Profile

The questionnaire was distributed to all scholars at the IPA who hold a Ph.D. degree ($N = 96$). Table 2 presents the participants' demographic data. Overall, the majority of respondents are male ($n = 67, 87.0\%$), aged between 40 and 49 years ($n = 44, 57.1$), while the remaining are female ($n = 10, 13\%$), aged between 40 and 49 years ($n = 44, 57.1$). Most respondents (63, 81.8%) are assistant professors. However, 16.9% of the participants are ranked as Law specialists ($n = 13, 16.9\%$), while the same percentage are education specialists and in public administration (9, 11.7%).

Table 2

Demographic Data of IPA Respondents (N = 77)

Variable	Frequency	%
Gender		
Male	67	87.0
Female	10	13.0
Age		
20-29	3	3.9
30- 39	15	19.5
40- 49	44	57.1
50- 60	15	19.5
Academic Rank		
Professor	5	6.5
Associate Professor	9	11.7
Assistant Professor	63	81.8
Academic Field		
Health Administration	4	5.2
Statistics	4	5.2
Public Administration	9	11.7
Engineering Management	3	3.9
Economics	5	6.5
Computer Science	7	9.1
Public Relations and Media	3	3.9
Law	13	16.9
Business Administration	7	9.1
English Language	7	9.1
Information Science	2	2.6
Human Resources Management/Education	13	16.9

Gender Profile

Data from this study reveals that 87% of the respondents are male (see Figure 10), and 13% only are female (see Figure 10).

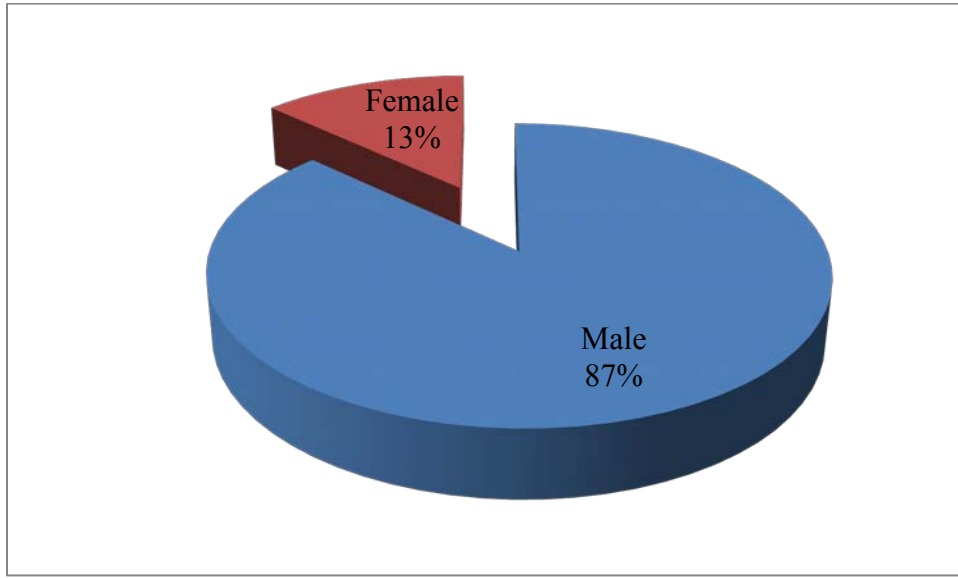


Figure 10. Gender distribution within the study sample ($n = 77$).

Age Profile

Age of respondents in this study ranges from 20 to 60 years. Approximately 57.1% are in the 40-49 age group and 19.5% are in the 30-39 age group. These two age groups collectively account for approximately three-quarters (76.6%) of the total sample. Also, data indicates that 19.5% are in the 50-59 age group, and 3.9% are in the 20-29 age group. Figure 11 illustrates the age groups of the respondents.

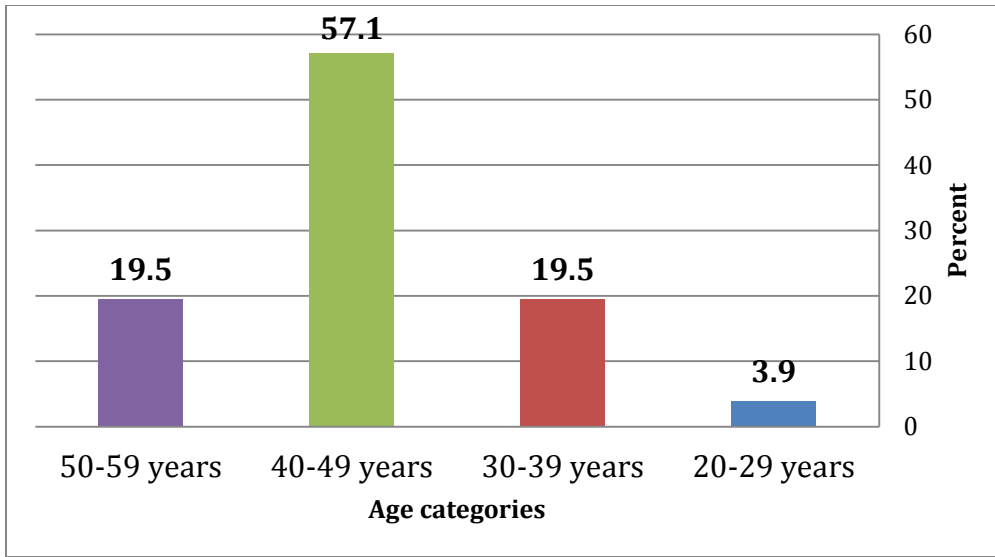


Figure 11. Age categories for the study sample ($n = 77$).

Academic Ranks Profile

Distribution of academic rank is as follows: 63 (81.8%) of the participants are assistant professors, nine (11.7%) of the participants are associate professors, and five (6.5%) of the participants are professors. Figure 12 illustrates the academic rank of the respondents.

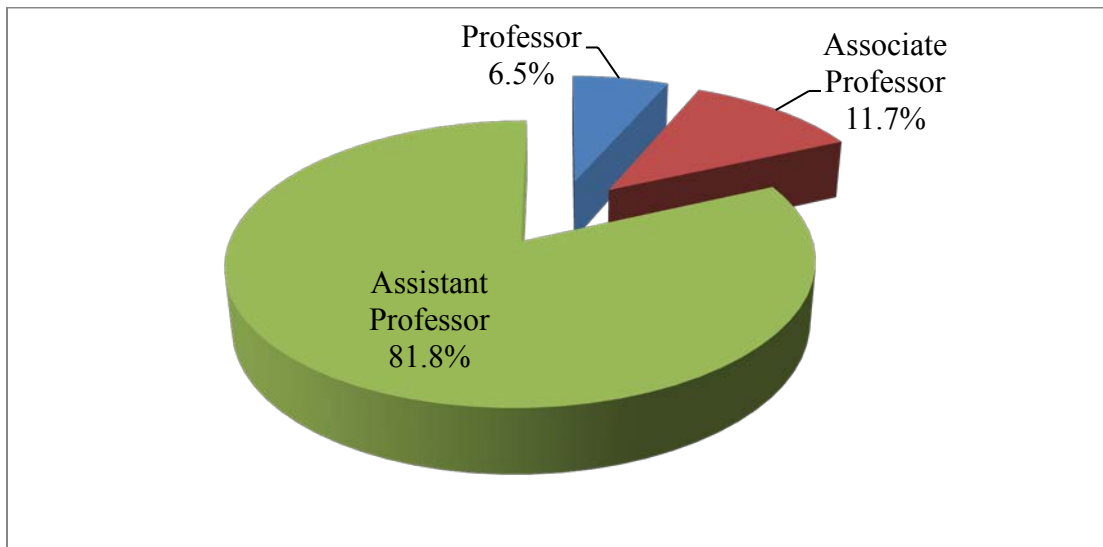


Figure 12. Academic ranks for the study sample ($n = 77$).

Academic Field Profile

Participants were divided into 12 categories according to academic field (see Figure 13). Academic fields are listed in descending order according to representation among participants. The two fields with the greatest representation are law ($n = 13$, 16.9%) and human resources management/education ($n = 13$, 16.9%). These fields have the highest representation because of the current nature of the IPA's focus on management programs and its master's in law program. Next is public administration ($n = 9$, 11.7%). Business administration ($n = 7$, 9.1%), English language ($n = 7$, 9.1%) and computer science ($n = 7$, 9.1%) are equally represented. Fields with less representation include economics ($n = 5$, 6.5%), health administration ($n = 4$, 5.2%), statistics ($n = 4$, 5.2%), engineering management ($n = 3$, 3.9%), public relations and media ($n = 3$, 3.9%), and finally, information science ($n = 2$, 2.6%).

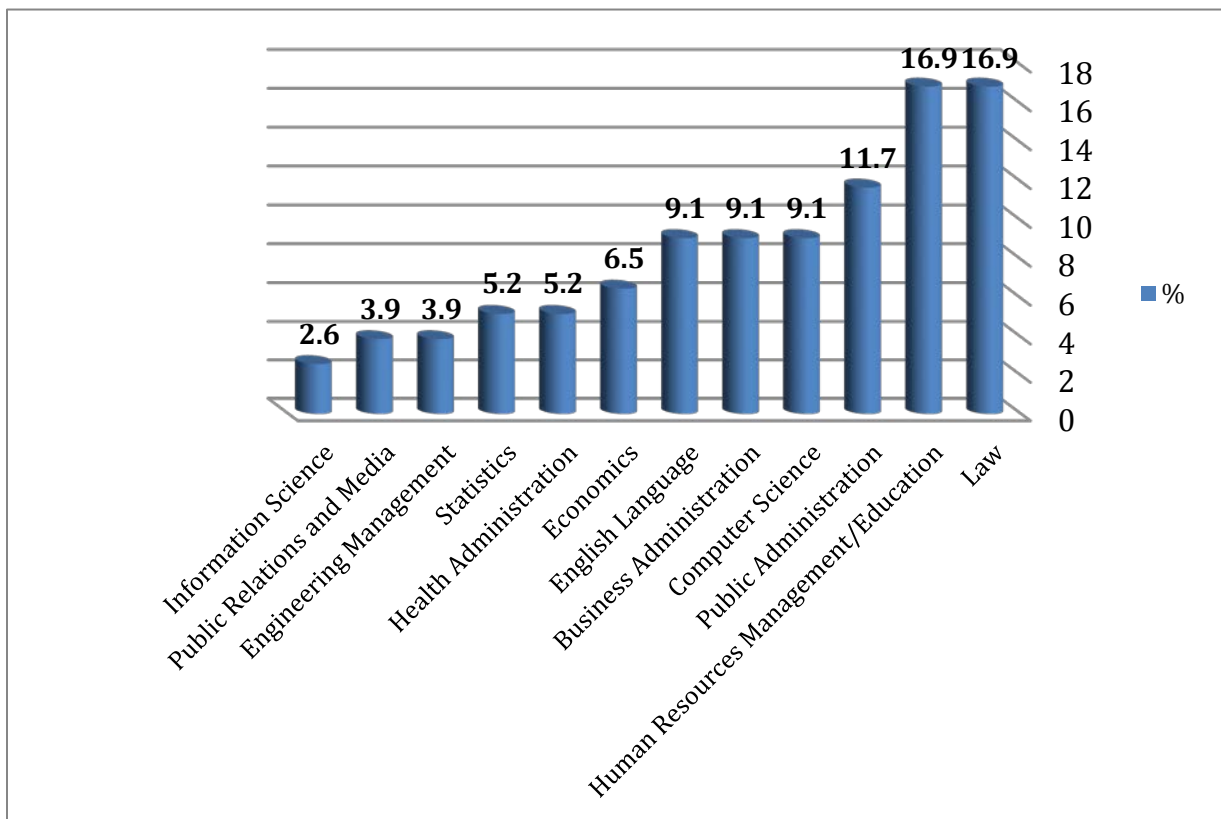


Figure 13. Academic field for the study sample ($n = 77$).

Distribution of the Rate of Social Media Use for Scientific Communication

The results shown in Table 3 indicate that 73 (94.8%) respondents responded affirmatively that social media is widely used for scientific communication purposes, while only 4 (5.2%) respondents said that social media is not used for scientific communication purposes. This is represented in Figure 5. This indicates that most participants are using social media for scientific communication purposes.

Scholars were also asked about their frequency of social media use for scientific communication purposes. The results in Table 3 show that 29 (37.7%) respondents use social media *constantly (once or more a day)*, 19 (24.7%) respondents use it *sometimes (twice a month)*, 14 (18.2%) respondents use it *often (once a week)*, and 11(14.3%) respondents use it *rarely (once a month)* (see Figure 14).

Table 3

Use of Social Media for Scientific Communication Purposes (n = 77)

	Frequency	Percent
Never	4	5.2
Rarely (once a month)	11	14.3
Sometimes (twice a month)	19	24.7
Often (once a week)	14	18.2
Constantly (once or more a day)	29	37.7
Total	77	100.0

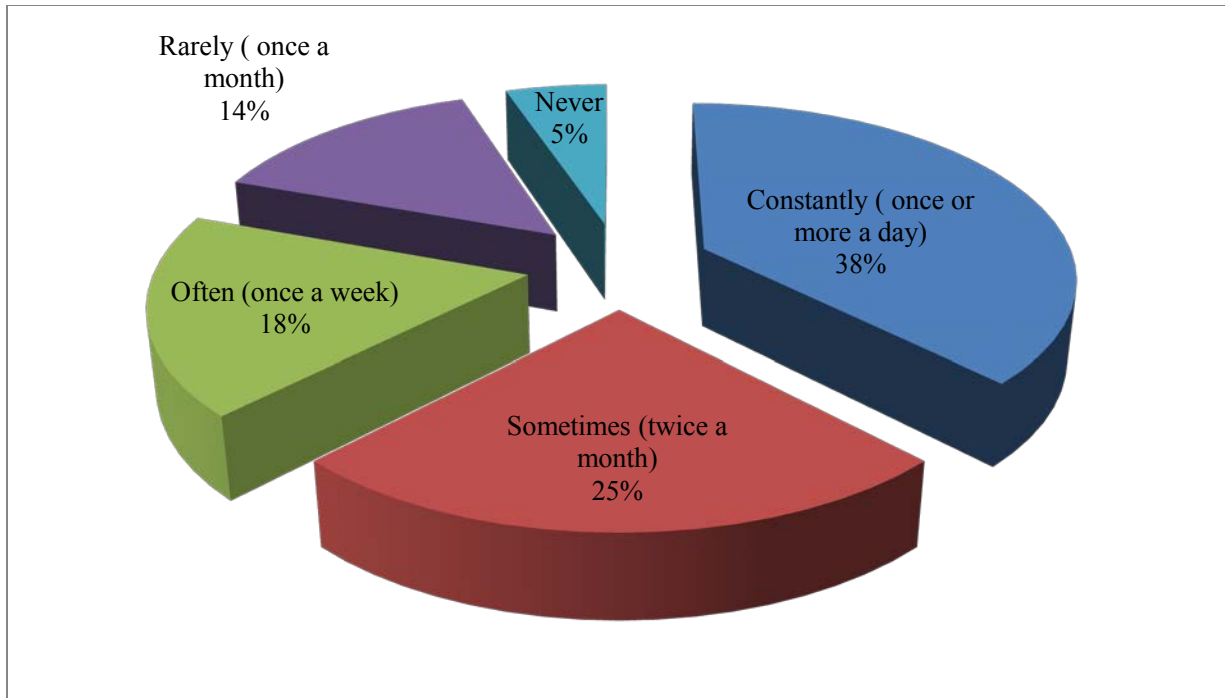


Figure 14. Scholars use of social media for scientific communication purposes.

Responses to the question of what type of technology is used to access social media platforms for communication are shown in Table 4. Forty-eight (65.7%) respondents use smartphones, 44 (60.3%) respondents use laptops, 43 (58.9%) respondents use PCs, and only 10 (13.7%) respondents use tablet computers. These results indicate that the most frequently used device for accessing social media platforms for communication is the Smartphone, while the least frequently used is the tablet computer (see Figure 15).

Table 4

Technology Use for Accessing Social Media Platforms for Communication

	Yes		No		Total	
	Frequency	%	Frequency	%	Frequency	%
Smartphones	48	65.7	25	34.3	73	100.0
PCs	43	58.9	30	41.1	73	100.0
Laptops	44	60.3	29	39.7	73	100.0
Tablet computer	10	13.7	63	86.3	73	100.0

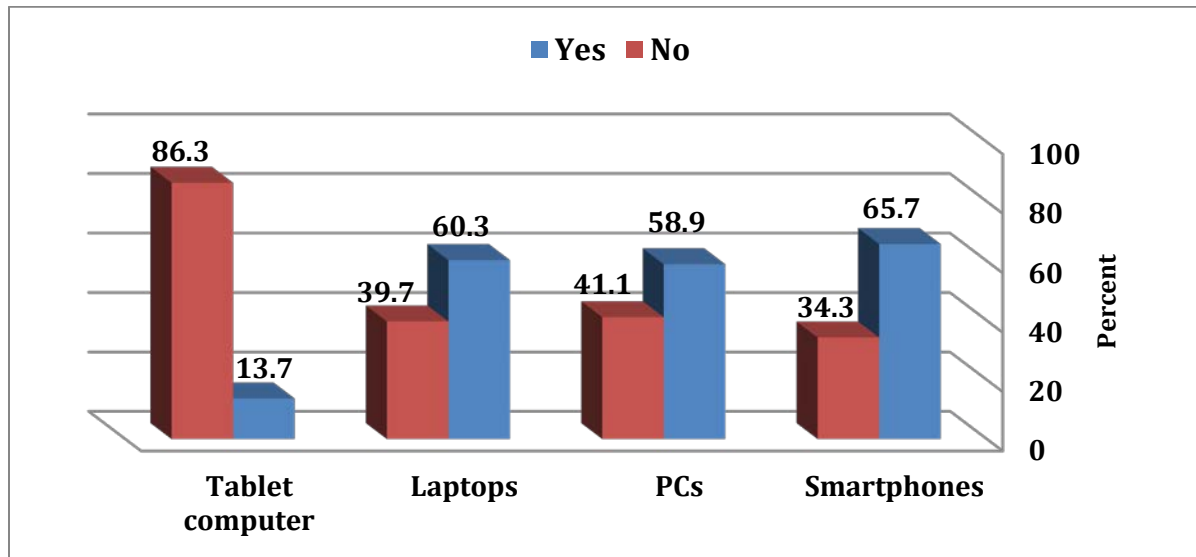


Figure 15. Technology use for accessing social media platforms for communication ($n = 73$).

Table 5

Social Media Tools as Scientific Communication Channels (n = 73)

Tools		Never	Rarely (once a month)	Sometimes (twice a month)	Often (once a week)	Constantly (once or more a day)	Missing values	Total	Mean	Std. deviation	Rank
Facebook	F	16.00	13.00	12.00	13.00	18.00	1.00	73.00	3.05	1.5	4
	%	21.9	17.8	16.4	17.8	24.7	1.4	100			
Twitter	F	12.00	14.00	16.00	15.00	14.00	2.00	73.00	3.07	1.3	3
	%	16.4	19.2	21.9	20.5	19.2	2.7	100			
MySpace	F	56.00	3.00	3.00	0	2.00	9.00	73.00	1.26	0.82	10
	%	76.7	4.1	4.1	0.0	2.7	12.3	100			
YouTube	F	14.00	12.00	7.00	18.00	16.00	6.00	73.00	3.15	1.5	2
	%	19.2	16.4	9.6	24.7	21.9	8.2	100			
Flickr	F	57.00	5.00	1.00	1.00	0	9.00	73.00	1.16	0.51	11
	%	78.1	6.8	1.4	1.4	0.0	12.3	100			
Skype	F	27.00	15.00	9.00	8.00	5.00	9.00	73.00	2.20	1.3	6
	%	37	20.5	12.3	11	6.8	12.3	100			
Blogs	F	40.00	12.00	6.00	3.00	3.00	9.00	73.00	1.70	1.1	9
	%	54.8	16.4	8.2	4.1	4.1	12.3	100			
Google+	F	20	5	6	8	28	6	73	3.28	1.7	1
	%	27.4	6.8	8.2	11	38.4	8.2	100			
LinkedIn	F	34	8	13	8	2	8	73	2.01	1.2	7
	%	46.6	11	17.8	11	2.7	11	100			
Instagram	F	43	7	6	3	5	9	73	1.75	1.2	8
	%	58.9	9.6	8.2	4.1	6.8	12.3	100			
Forums	F	26	13	10	9	6	9	73	2.31	1.3	5
	%	35.6	17.8	13.7	12.3	8.2	12.3	100			

Scholars were asked about the social media tools they use for scientific communication. The means and the standard deviations for each social media tool used for scientific communication are shown in Table 4. Based on the results shown in Table 5, means scores were above the mid-point of the 5-point scale for Google+ (3.28), YouTube (3.15), Twitter (3.07), and Facebook (3.05), while the lowest was Flickr (1.16). These results indicate that Google+, YouTube, Twitter, and Facebook are the most commonly used platforms for scientific communication (see Figure 16). Unsurprisingly, scholars at the IPA use scientific films as case studies in classes and to share media with colleagues, due to the current nature of the IPA’s focus on training. This is the reason YouTube rates so high for use of social media for scientific communication.

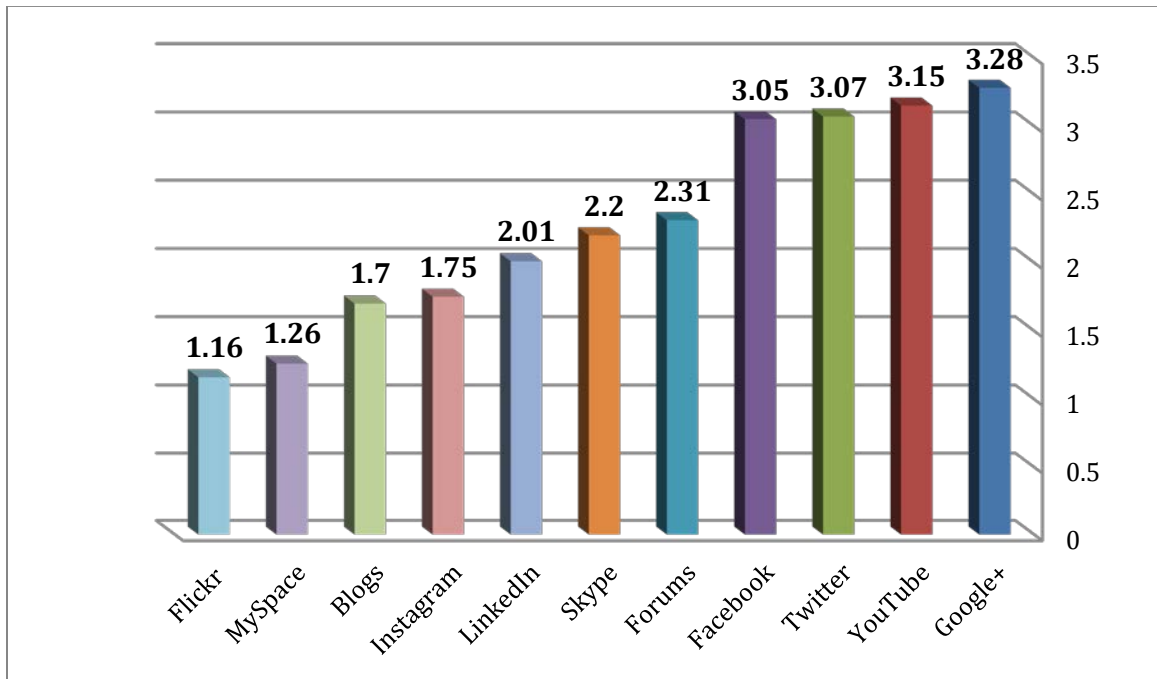


Figure 16. Social media tools used as scientific communication channels.

Table 6

Appropriate Informal Communication Channel (n = 73)

	Yes		No		Total	
	F	%	F	%	F	%
I choose the appropriate social media that fits my needs and that does not require skills and experiences.	56	76.7	17	23.3	73	100.0
I choose the appropriate social media that helps me to disseminate my scientific work.	54	73.9	19	26.1	73	100.0
I choose the appropriate social media that performs better with an article link and text.	59	80.8	14	19.2	73	100.0
I choose the appropriate social media to help me reach my goals.	62	84.9	11	15.1	73	100.0
I use multiple social media tools to support multiple goals.	47	64.4	26	35.6	73	100.0
I think selecting the appropriate social media tool will help me to identify the best way to reach my target audience.	59	80.8	14	19.2	73	100.0

The results in Table 6 indicate, 62 (84.9 %) respondents choose the appropriate social media to help them reach their goals, 59 (80.8 %) respondents choose the appropriate social media that performs better with an article link and text, 59 (80.8 %) respondents think selecting the appropriate social media tool will help them to identify the best way to reach their target audience, 56 (76.7 %) respondents choose the appropriate social media that fits their needs and

that does not require skills and experiences, 54 (73.9 %) respondents choose the appropriate social media that helps them to disseminate their scientific work, and finally, 47 (64.4%) respondents use multiple social media tools to support multiple goals.

Table 7

Social Media Tools Used Most Frequently as Channels of Scientific Communication (n = 73)

Social media tools	Frequencies
Facebook	43
Twitter	30
MySpace	3
YouTube	40
Flickr	4
Skype	13
Blogs	13
Google+	36
LinkedIn	24
Instagram	4
Forums	20

The results in Table 7 indicate which social media tools are most frequently used as channels of scientific communication. The responses in descending order of popularity are as follows: Facebook (43), YouTube (40), Google (36), Twitter (30), LinkedIn (24), Forums (20), Skype (13), Blogs (13), Flickr (4), Instagram (4), and finally, MySpace (3). This is represented in Figure 17.

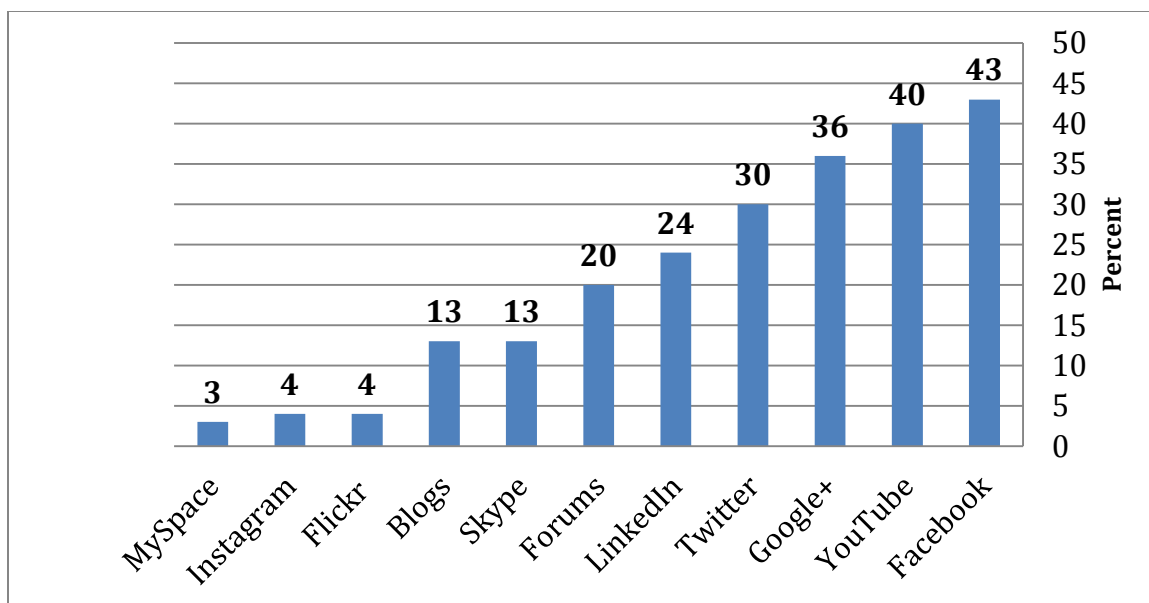


Figure 17. Social media tools most frequently used as channels of scientific communication.

Table 8

Reasons to Use Social Media for Scientific Communication (n = 73)

	Yes		No		Missing value		Total	
	N	%	N	%	N	%	N	%
I use social media because I need to explore new issues about my field.	68	93.2	5	6.8	-	-	73	100.0
I use social media because I consider it as a good tool for scientific communication.	66	90.4	7	9.6	-	-	73	100.0
I use social media because I consider it as a good tool to interact with scholars.	55	75.3	17	23.3	1	1.4	73	100.0
I use social media because I consider it as a good tool to introduce myself to others.	52	71.2	20	27.4	1	1.4	73	100.0

(table continues)

(table continued)

I use social media because it gives me an opportunity to hear directly from others.	65	89.1	8	10.9	-	-	73	100.0
I feel that using social media is appropriate to share my research papers.	38	52.1	34	46.5	1	1.4	73	100.0
I feel that using social media is an appropriate tool to gain knowledge.	62	84.9	11	15.1	-	-	73	100.0
I think social media is an easy and fast tool to share my opinion.	70	95.9	2	2.7	1	1.4	73	100.0
I think social media is different from traditional forms of communication.	64	87.7	8	10.9	1	1.4	73	100.0
I believe that using social media will improve my productivity.	52	71.2	20	27.4	1	1.4	73	100.0

Table 8 shows responses to the question about reasons for the use of social media for scientific communication. As the results indicate, 70 (95.9%) respondents said that social media is an easy and fast tool to share their opinions; 68 (93.2%) respondents use social media because they need to explore new issues about their fields; 66 (90.4%) respondents use social media because they consider it a good tool for scientific communication; 65 (89.1%) respondents use social media because it gives them an opportunity to hear directly from others; 64 (87.7%) respondents use social media because they think that it differs from traditional forms of communication; 62 (84.9%) respondents use social media because they feel that using social media is an appropriate tool to gain knowledge; 55 (75.3%) respondents use social media because they consider it as a good tool to interact with scholars; 52 (71.2%) respondents use social media because they consider it as a good tool to introduce themselves to others; 52

(71.2%) respondents believe that using social media will improve their productivity; and finally, 38 (52.1%) respondents feel that using social media is appropriate to share their research papers.

Table 9

Scholars Perceive Social Media as Useful for Scientific Communication (n = 73)

	Yes		No		Missing value		Total	
	N	%	N	%	N	%	N	%
Has using social media tools made it easier to keep in contact with scholars, researchers, and colleagues?	67	91.8	6	8.2	-	-	73	100.0
Do you ever use social media tools to stay in touch with colleagues you rarely see in person?	55	75.3	18	24.7	-	-	73	100.0
Does using social media tools facilitate your communicating with scholars better than with traditional face-to-face meetings?	65	89.1	8	10.9	-	-	73	100.0
Does using social media tools help you to exchange and share information, knowledge, documents, and links with other scholars?	60	82.2	13	17.8	-	-	73	100.0
Does using social media tools facilitate conversation and feedback with scholars?	64	87.7	8	10.9	1	1.4	73	100.0
Does using social media tools help you to establish relationships with other scholars?	59	80.8	14	19.2	-	-	73	100.0
Do you use social media to find information or related subjects to your research interest?	62	84.9	11	15.1	-	-	73	100.0

(table continues)

(table continued)

Are you interested in using social media for scientific communication?	55	75.3	18	24.7	-	-	73	100.0
Do you consider social media useful tools for scientific communication?	61	83.6	12	16.4	-	-	73	100.0
Do you consider social media appropriate tools for scientific communication?	62	84.9	11	15.1	-	-	73	100.0

In regard to the scholars' perception of social media as useful for scientific communication, Table 9 indicates that 67 (91.8%) respondents said that social media tools made it easier to keep in contact with scholars, researchers, and colleagues; 65 (89.1%) respondents said that using social media facilitates their communication with scholars better than traditional face-to-face meetings; 64 (87.7%) respondents said that social media tools facilitate conversation and feedback with scholars; 62 (84.9%) respondents said that social media helps them to find information or subjects related to their research interest; 62 (84.9%) respondents consider social media to be an appropriate tool for scientific communication; 61 (83.6%) consider social media useful for scientific communication, 60 (82.2%) respondents said that social media tools help them to exchange and share information, knowledge, documents, and links with other scholars; 59 (80.8%) respondents said that using social media tools help them to establish relationships with other scholars; 55 (75.3%) respondents said that social media helps them to stay in touch with colleagues they rarely see in person; finally, 55 (75.3%) respondents said they are interested in using social media for scientific communication.

Crosstab analyses using Pearson's Chi-Square tests were conducted to analyze whether there were relationships amongst gender, age, academic rank, and academic field and using social media tools as scientific communication tools. The outputs are as follows:

Gender and Using Social Media Tools as Scientific Communication Tools

The relationship between gender and using social media tools as scientific communication tools was investigated by cross tabulating the variable "gender" and the question which was worded "Why do you use social media for scientific communication?" The results of the cross tabulation captured in Table 10 reveal that a person's Chi-Square test values ranged from .002 to 2.05, which implies that there is no significant relationship between gender and the use of social media tools as scientific communication tools.

Table 10

The Relationship Between Gender and Social Media for Scientific Communication

	Chi-Square value	df	Sig.
I use social media because I need to explore new issues about my field.	.180	1	.671
I use social media because I consider it as a good tool for scientific communication.	.002	1	.962
I use social media because I consider it as a good tool to interact with scholars.	.011	1	.916
I use social media because I consider it as a good tool to introduce myself to others.	1.42	1	.233
I use social media because it gives me an opportunity to hear directly from others.	.011	1	.917
I feel that using social media is appropriate to share my research papers.	.032	1	.858
I feel that using social media is an appropriate tool to gain knowledge.	2.05	1	.152
I think social media is easy and fast tool to share my opinion.	.294	1	.588
I think social media is different from traditional forms of communication.	1.28	1	.257
I believe that using social media will improve my productivity.	.158	1	.691

Age and Using Social Media Tools as Scientific Communication Tools

The relationship between age and using social media tools as scientific communication tools was investigated by cross tabulating the variable "age" and the question which was worded "Why do you use social media for scientific communication?" The results of the cross tabulation captured in Table 11 reveal that a Pearson's Chi-Square test values ranged from .832 to 3.96, which implies that there is no significant relationship between age and use of social media tools as scientific communication tools.

Table 11

The Relationship Between Age and Using Social Media for Scientific Communication

	Chi-Square value	df	Sig.
I use social media because I need to explore new issues about my field.	3.74	3	.290
I use social media because I consider it as a good tool for scientific communication.	3.96	3	.265
I use social media because I consider it as a good tool to interact with scholars.	1.45	3	.693
I use social media because I consider it as a good tool to introduce myself to others.	2.39	3	.494
I use social media because it gives me an opportunity to hear directly from others.	2.52	3	.47
I feel that using social media is appropriate to share my research papers.	3.22	3	.359
I feel that using social media is an appropriate tool to gain knowledge.	1.46	3	.689
I think social media is easy and fast tool to share my opinion.	1.65	3	.648
I think social media is different from traditional forms of communication.	5.26	3	.154
I believe that using social media will improve my productivity.	.832	3	.842

Academic Rank and Using Social Media Tools as Scientific Communication Tools

The relationship between academic rank and the use of social media tools as scientific communication tools was investigated by cross tabulating the variable "academic rank" and the question which was worded "Why do you use social media for scientific communication?" The results of the cross tabulation captured in Table 12 reveal that a Pearson's Chi-Square test values for all items except the item, "I think social media is different from traditional forms of communication," ranged from .015 to 3.18, which implies that there is no significant relationship between academic rank and these items. Regarding the item, "I think social media is different from traditional forms of communication," the Pearson's Chi-Square test value of .037 reflected in Table 12 indicates a significant relationship between academic rank and this item. From the above findings, there is a partial relationship between academic rank and the use of social media tools as scientific communication tools.

Table 12

The Relationship Between Academic Rank and Using Social Media for Scientific Communication

	Chi-Square value	df	Sig.
I use social media because I need to explore new issues about my field.	1.16	2	.559
I use social media because I consider it as a good tool for scientific communication.	1.67	2	.432
I use social media because I consider it as a good tool to interact with scholars.	.015	2	.992
I use social media because I consider it as a good tool to introduce myself to others.	1.72	2	.424
I use social media because it gives me an opportunity to hear directly from others.	.666	2	.717
I feel that using social media is appropriate to share my research papers.	.045	2	.978
I feel that using social media is an appropriate tool to gain knowledge.	1.05	2	.592
I think social media is easy and fast tool to share my opinion.	3.18	2	.203

(table continues)

(table continued)

I think social media is different from traditional forms of communication.	6.609	2	.037
I believe that using social media will improve my productivity.	2.215	2	.330

Academic Field and Using Social Media Tools as Scientific Communication Tools

The relationship between academic field and the use of social media tools as scientific communication tools was investigated by cross tabulating the variable "academic field" and the question which was worded "Why do you use social media for scientific communication?" The results of the cross tabulation captured in Table 13 reveal a Pearson's Chi-Square test values for all items except the item, "I think social media is an easy and fast tool to share my opinion," ranged from 6.92 to 17.80, which implies that there is no significant relationship between academic rank and these items. Regarding the item, "I think social media is an easy and fast tool to share my opinion," the Pearson's Chi-Square test value of .000 reflected in Table 13 indicates a significant relationship between academic rank and this item. From the above findings, there is a partial relationship between academic field and using social media tools as scientific communication tools.

Table 13

The Relationship Between Academic Field and Using Social Media for Scientific Communication

	Chi-Square value	df	Sig.
I use social media because I need to explore new issues about my field.	10.05	11	.526
I use social media because I consider it as a good tool for scientific communication.	17.80	11	.086
I use social media because I consider it as a good tool to interact with scholars.	13.24	11	.278
I use social media because I consider it as a good tool to introduce myself to others.	10.34	11	.500
I use social media because it gives me an opportunity to hear directly from others.	9.64	11	.563
I feel that using social media is appropriate to share my research papers.	6.92	11	.806
I feel that using social media is an appropriate tool to gain knowledge.	12.74	11	.311
I think social media is easy and fast tool to share my opinion.	47.31	11	.000
I think social media is different from traditional forms of communication.	12.14	11	.353
I believe that using social media will improve my productivity.	16.11	11	.137

Barriers Prevent Scholars From Using Social Media Tools for Scientific Purposes

Table 14

Barriers Prevent Scholars From Using Social Media Tools for Scientific Communication Purposes (n = 73)

	Yes		No		Missing value		Total	
	N	%	N	%	N	%	N	%
I feel that the privacy of my personal information on social media is not protected.	50	68.5	23	31.5	-	-	73	100.0
I do not trust social media because my personal information could be used for another purpose.	45	61.6	28	38.4	-	-	73	100.0
I do not have enough skills to use social media.	12	16.4	61	83.6	-	-	73	100.0
I do not have enough time to use social media.	32	43.8	41	56.2	-	-	73	100.0
I do not use social media because of technical issues.	11	15.1	62	84.9	-	-	73	100.0
I do not feel confident enough to use social media.	36	49.3	37	50.7	-	-	73	100.0
I believe that some social media requires too much mental effort.	15	20.5	58	79.5	-	-	73	100.0
I think social media is not an easy tool to set up and maintain.	16	21.9	57	78.1	-	-	73	100.0

Scholars in the study were asked about barriers that prevent them from using social media tools for scientific purposes. Table 14 demonstrates that the most significant barriers mentioned by scholars are: "I feel that the privacy of my personal information on social media is not protected" ($n = 50, 58.5\%$); "I do not trust social media because my personal information could be used for another purpose" ($n = 45, 61.6\%$); "I do not feel confident enough to use social

media" ($n = 36, 49.3\%$); and finally, "I do not have enough time to use social media" ($n = 32, 43.8\%$). For the privacy issue, Baruah (2012) states that "sometimes, such tools are misused by people which leads to interference into one's privacy" (p. 1).

Faculty Members Comments and Suggestions

The last section of the questionnaire asked scholars to include any comments or concerns they wanted to address. In this section, some respondents repeatedly indicated the two main current obstacles of using social media are the workload and the lack of time affecting their use of social media tools. One of the respondents commented: "The use of social media for scientific communication and research can reduce the time and the effort." Additionally, several participants indicated that they often use Google+ and Google Drive for communicating and delivering PDFs and mp3s (audio files) to or from colleagues. For instance, one participant commented: "I use Google+ to communicate with my colleagues a lot—it's a user-friendly platform, and they can access the papers and other materials from almost anywhere as long as there is Internet access." This finding is not surprising, as Google+ was the highest-ranked social media tool. One of the respondents commented: "I use social media to get more experience from others but I don't use it to disseminate my thoughts and work because there is no copyright and anything is considered to be in the public domain".

Some of the participants commented by adding a particular social media tool such as WhatsApp, which is used by some participants for scientific communication. A participant commented: "WhatsApp services became an effective and popular tool among professionals and non-professionals in Saudi Arabia." Other comments can be summarized as follows: Information overloads and no privacy or confidentiality as obstacles and challenges prevent more frequent

use of social media. Some respondents suggested providing the IPA's faculty members with classes and training about using social media for scientific communication.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

This study has explored scholars' perceptions of the practical use of informal communication channels and social media tools for scientific communication based on responses by scholars at the Institute of Public Administration in Saudi Arabia. This study seeks to interpret these responses in terms of uses and gratifications theory that demonstrate the ways in which scholars decide to use a particular social media tool. Additionally, this study aims to facilitate understanding of the fundamental goal of the invisible college through the building of the MICM model.

The results of this study will aid researchers, academic practitioners, and future participants in the invisible college to better understand the invisible college phenomenon, its social processes, and its informal communication channels. Moreover, the results could contribute to enhancement of the services available through informal communication channels including social media.

The discussion and interpretation of the findings in this chapter will start by addressing each research questions individually and then move to contributions, limitations, and implications. It will end with the conclusion and, finally, recommendations for future research.

Interpretation of Findings

Rate of Social Media Use for Scientific Communication

Q1. To what extent are the scholars at the Institute of Public Administration using social media for scientific communication?

The results related to utilization of social media for scientific communication purposes indicate mostly affirmative responses, demonstrating that the respondents use social media for

scientific communication purposes. This confirms other findings showing that respondents were generally positive in their attitudes about the effectiveness and potential contribution of social media in its role. For instance, Cruz's and Jamias' (2013) study revealed that most of the participants use social media more heavily as a communication tool. Additionally, they found that scientific use of social media for communication and scholarly purposes, such as collaboration and research, have resulted in a further increase in the pace of scientific investigation. Overall, this study and previous studies indicate that the participants were satisfied with social media as a communication tool. More clearly, Eperen, and Marincola (2011) stated that social media "has enabled them to communicate their research quickly and efficiently throughout each corner of the world" (p. 1).

Participants were asked about the frequency of their use of social media for scientific communication purposes. The results indicate that the greatest proportion of respondents 29 (37.7%) use social media constantly (once or more a day). These results indicate that participants rely heavily on social media for scientific communication purposes. In a previous study, Moran et al. (2011) reports similar results that 60% of respondents use at least one social media site at least once a month.

Responses to the question of what type of technology is used to access social media platforms for communication indicate that the greatest proportion of respondents, 48 (65.7%), use smartphones to access social media. These results indicate that the most frequently used device for accessing social media platforms for communication is the smartphone, while the least frequently used is the tablet computer. Generally, these findings are not consistent with previous research that investigated participants' use of devices in order to access social media. According to an earlier report by Singh & Gill (2011), 65% of participants used PCs to access social media

while only 12.5% of participants relied on their smartphones. Nowadays, as with most of smartphone's users, the availability of personal access to a smartphone and the ease and convenience of access information online changes the communication dynamic for scholars. Since the birth of the smartphone, users have the ability to use their own devices at homes, schools, works, markets, and etc. whether for personal communications or other purposes. Thus, the ability to use the smartphone and its applications that scholars already use into their daily life will be critical to the future direction and success of the scientific communication.

Q 1a. How do these scholars decide which informal communication channel is appropriate for their communication?

Generally, the findings indicated that scholars choose social media tools in order to reach their goals, target audiences, disseminate their scientific work, and to best carry out objectives. This means that participants had already decided to choose particular informal communication channels for scientific communication, according to the categories mentioned earlier. This is to say that the participants were familiar with social media tools previous to the study.

Many studies have indicated that social media use is becoming more prevalent in institutions around the world (Hamid et al., 2011; Parveen, 2011); social media applications have already been accepted by individuals as informal channels by which to communicate, socialize, and collaborate informally (Singh & Gill, 2011; Zakaria, Watson, & Edwards, 2010). Accordingly, this present study defines the use of social media for scholars as a set of activities such as sharing information, knowledge, insights, and common interests, establishing new relationships with other scholars, and exchanging ideas and research works or sources, that may facilitate communication practices in scientific fields. This study support several studies that indicated that social media provide a significant service to scholars in facilitating informal

scientific communication (Bik & Goldstein, 2013; Cruz and Jamias, 2013; Eperen & Marincola, 2011; Gu & Widen-Wulff, 2011; Gruzd et al., 2012; Rowlands, Nicholas, Russell, Canty, & Watkinson, 2011; Veletsianos & Kimmons, 2013).

Q 1b. What social media do scholars use most frequently for scientific communication?

The findings revealed that Facebook, YouTube, Google+, and Twitter, were the most frequently social media tools used as channels of scientific communication. In accordance with the present findings, previous studies have similar outcomes. Mostly, the findings were consistent with Singh's and Gill's (2011) findings that reported Facebook was the top platform that most respondents used for their scientific communication. Singh and Gill (2011) examined the use of social networking sites by research scholars. Based on their results, the majority of respondents used social media in their research, and Facebook, YouTube, Twitter, and Google+ were the preferred social media tools among research scholars. Furthermore, Moran et al. (2011) conducted a survey on faculty from all disciplines of higher education in the U.S. and found that almost every user of social media used at least one social media site; more specifically, Moran et al. (2011, p. 9) indicated that 78% of all faculty reported using at least one social media site in support of their professional career activities.

Generally, social media tool like Facebook, YouTube, Google+, and Twitter are growing stronger each day. Thus, these platforms attempt to attract more people with several services and features in order to using them frequently. Recently, statistical report by Bullas (2014) has revealed that Facebook, Google+, and Twitter are the most popular tools among social media tools. Moreover, Facebook is still the greatest platform on the social media tools, "but there are some pundits predicting that by 2016 Google+ will surpass Facebook".

Q 2. Why do scholars use social media for scientific communication?

The results indicate that respondents feel that using social media is appropriate for sharing their research, an easy and fast tool to share their opinions, and to explore new issues about their fields. Thus, the responses to this question confirm that scholars consider social media to be an effective and appropriate tool for scientific communication. Most of the respondents agreed that using social media benefits them for scientific communication. Given this, it appears that the use of social media as a tool might be a new methods for scientific communication and for other scientific purposes. Moreover, Osterrieder (2013) stated “actively participating in social media networks allows scientists to disseminate research findings quickly and effectively as well as raise their own profile, of their research groups or institution” (p. 3). Participants seemed to have positive attitudes towards the benefits of using social media for different purposes. Generally, the findings confirm that participants used social media because of the value and the benefits of it and it also was a suitable and valuable platform for scientific communication. The next two questions are related to this question and they explain scholars’ perception about the usefulness of using social media and the factors that may influence using social media for scientific communication.

Q 2a. To what extent do these scholars perceive social media as useful for scientific communication?

Results confirm that respondents consider social media tools to be useful for scientific communication. Specifically, a majority of respondents believe that using social media tools makes it easier to keep in contact with scholars, researchers, and colleagues, and that social media tools are superior to traditional face-to-face meetings for conducting scientific communication. The respondents also feel that social media tools help to facilitate conversation and feedback with scholars and that social media tools help them to find, share, and exchange

information or information related to their research interest with colleagues. A slightly lesser majority of respondents said that social media helps them to establish relationships with other scholars or to stay in touch with colleagues they rarely see in person. Most results mirror these findings and reported a positive perception by scholars for using social media as a tool for scientific communication (Cruz & Jamias, 2013; Moran et al., 2011 and Procter et al., 2010). Moreover, Procter et al., (2010) reported that scholars perceived social media services as an efficient platform because social media offers “new channels through which researchers can seek information relevant to their work” (P. 34). Additionally, Cruz & Jamias (2013) reported, “different scientific discipline groups view the usefulness of various social media tools” (p. 7). However, the participants in this current study see considerable value of using social media for different purposes.

Generally, the findings confirm that participants have a positive opinion towards social media tool that supports participants’ needs and help fulfill communication wants. It provides the ability to stay connected with colleagues and it is a convenient tool of communication that facilitates the method of scientific communication.

Q 2b. What factors influence scholars’ perceptions of using social media tools for scientific communication?

Although social media is a great tool for communication, it is not without its pitfalls or problems. Thus, while the findings in the previous questions indicated the benefits and usefulness of using social media for scientific communication, the results in this section indicate that the most significant barrier mentioned by participants is concern that personal information shared on social media could be used for other purposes. The participants were concerned about personal information privacy. Baruah (2012) states that “sometimes, such tools are misused by

people which leads to interference into one's privacy" (p. 1). These findings are supported by Moran (2011) who found that privacy is the most concern for using social media by participants. In addition, if social media's users do not use the private communication methods or settings that available on most of the social media tools such as Google+, Twitter, Facebook, etc., thus the public will be able to view their profiles, contents, and privacies. For example, social media tools provide some features that can help its users to hide their profiles from the public. Obviously, the public can access to social media users' profiles and content that posted and published by other users, it is not surprising that the personal information and contents appear to people. Social media users can use some of the features that may help them to control their profiles but they cannot protect their profiles from social media itself or from the third party. In other ways, Shehab et al., (2012) pointed out "these open interfaces pose serious privacy concerns as third party applications are usually given access to the user profiles". Moreover, they emphasized, "Controlling access to the information posted on user profile is a challenging task as it requires average Internet users to act as system administrators to specify and configure access control policies for their profiles" (p. 897).

Overall, it seems that social media tool do not offers to its users the flexibility of controlling their privacy. Thus, several studies point to numerous privacy concerns associated with using social media. In spite of those concerns, however, participants believe that social media tools offer value in communication with others.

Gender, Age, Academic Rank and Academic Field and Using Social Media Tools

The relationship amongst gender, age, academic rank, and academic field and using social media tools as scientific communication tools is as follows:

Gender factors have been studied to determine their influence on the use of social media for scientific communication. The findings indicate that there is no significant relationship between gender and the use of social media for scientific communication. This result corresponds with other studies by Moran (2011) and Singh & Gill, (2011) that provided similar results. If there was no relationship between gender and the use of social media, then the researcher would expect that there is no influence on the participants' use of social media.

Age factors were studied to determine the value range of using social media for scientific communication among scholars. The results indicate that there is no significant relationship between age and use of social media for scientific communication. Thus, these findings are consistent with previous research reporting that all age groups use social media (Moran, 2011; Singh & Gill 2011). This means that participants have significant awareness of the use of social media and they accepted social media as a channel for their scientific communication.

Academic rank and field factors were studied to determine the value range for the use of social media for scientific communication among scholars. The results acquired from responses to various statements indicate that there is no significant relationship between academic rank and field and the use of social media for scientific communication.

Generally, the findings indicated that there is no significant relationship between academic rank and field and using social media for scientific communication. On one hand, the academic rank and field factors did not show an influence on the use of social media, on the other hand, it seems that respondents with their academic ranks and fields did not conflict with the use of social media for scientific communication. These results reflect a positive impression about the relationship of academic rank and field factors and the use of social media for scientific communication.

Q 3. How can uses and gratifications theory explain the use of social media among scholars for scientific communication?

In this study, the researcher applies the uses and gratifications theory to better understand what were scholars' perceptions of using social media for scientific communication and which social media tools were most used by scholars. Lievrouw and Carley (1990) indicate that scholars choose certain channels for informal communication based on perceptions of relevance. Additionally, past studies by Moran, Seaman, & Tinti-Kane (2011) and Singh & Gill, (2011), demonstrate that social media have fundamentally changed informal communication among scholars.

The results revealed seven main factors of uses and gratifications that scholars derived from using social media for scientific communication: 1) social media tools make sharing opinions fast and easy; 2) social media tools facilitate exploration of new field-related issues; 3) social media tools facilitate the finding of information or subjects related to research interests; 4) social media is effective and appropriate as a tool for scientific communication; 5) social media allows users to learn from others; 6) it facilitates communication with scholars more effectively and efficiently than traditional face-to-face meetings; and finally, 7) social media facilitate conversation and feedback with scholars. All of the seven factors were found to have positive correlations with uses and gratifications theory and the use of social media by participants. This implies that the ultimate goal of social media use is for interaction and communication with others. These findings are consistent with previous studies regarding uses and gratifications and social media. For instance, three of the five grounding assumptions of uses and gratifications theory state that (a) people take the initiative in selecting and using communication vehicles to satisfy felt needs or desires; (b) media compete with other forms of communication (i.e.,

functional alternatives) for selection, attention, and use to gratify our needs or wants; and (c) people are typically more influential than the media in the relationship, but not always (Rubin, 1994, p. 420). In contrast, Gruzd et al. (2012) assert that social media gives the “ability to facilitate collaboration and communication between peers (especially internationally and across disciplinary boundaries) and with people outside academia.” (p. 2341). Thus, social media provide a significant service to scholars in facilitating informal scientific communication (Bik & Goldstein, 2013; Cruz and Jamias, 2013; Eperen & Marincola, 2011; Gu & Widen-Wulff, 2011; Gruzd et al., 2012; Rowlands, Nicholas, Russell, Canty, & Watkinson, 2011; Veletsianos & Kimmons, 2013). In short, the uses and gratifications theory examines how scholars use social media for scientific communication from a participant’s perspective.

Contributions and Limitations

The concept of the invisible college is a key focus of scientific communication research, with many studies on this topic discussed in Chapter Two. However, while such studies have contributed to an understanding of the invisible college, they have not adequately explained the interaction of social and structural processes in this phenomenon. As a consequence, past research has described the invisible college differently based on researchers’ perspectives, resulting in misinterpretations or inconsistent definitions of the relevant social and structural processes. Information science and related disciplines have focused on the structural processes that lead to scholarly products or works while placing less emphasis on the social processes.

To advance understanding of the invisible college and its dimensions (including both social processes and structural processes), a proposed model has been built, based on the history of the invisible college (The modern invisible college model or MICM), as illustrated in Figure 18 and Lievrouw’s (1989) distinction between social and structural processes (as explained in Chapter

Two).

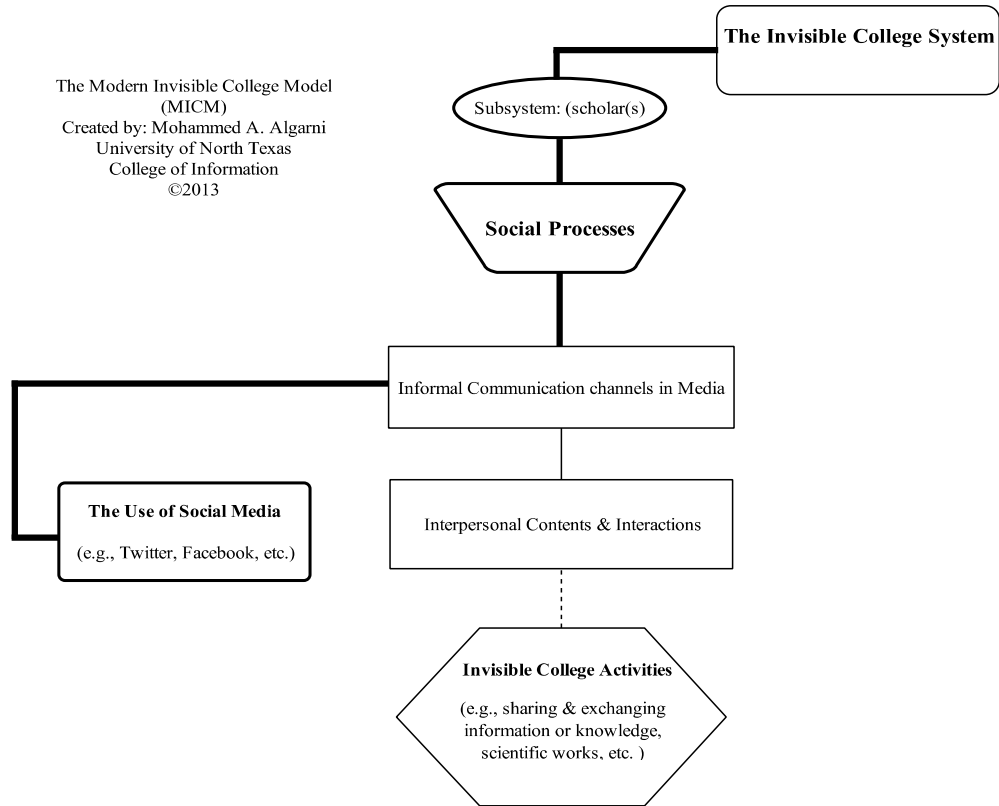


Figure 18. The modern invisible college: Social processes that focus on social media.

The present study focuses on the social processes of informal communication between scholars via social media, rather than on the structural processes that lead to scholarly products or works. Additionally, very little is known about the invisible college in non-Western, non-English-speaking developed societies, such as those of the Middle East. In particular, relatively few texts are available in the Arabic language, which may present a barrier to understanding the concept of the invisible college. These factors indicate that the existing uses and gratifications theory and the model of MICM may play a significant role in facilitating understanding of the use of social media for scientific communication among scholars, since there is still much to learn about present-day use of social media tools among scholars in most public organizations and in certain societies, and particularly among some scholars in non-English speaking

developing countries. There are, therefore, some gaps in the field of information science about the invisible college, informal communication channels, and scientific communication which must be addressed by research among information science scholars and related disciplines.

This study makes a significant theoretical contribution to knowledge in this area by addressing both of these information gaps and collecting information on the use of social media for scientific communication among scholars in Saudi Arabia. More generally, it helps to update the theoretical and conceptual base in which information science is grounded. Moreover, the model of MICM contributes to understand the invisible college and its dimensions (social processes and structural processes).

Overall, the theoretical significance of this study is to provide information on which the present-day relevance and cross-cultural applicability of the established theory (uses and gratifications theory) and modern invisible college model (MICM) can be assessed, and furthermore, so that updates or refinements can be identified and remedied. Additionally, this study will benefit scholars, reference groups (i.e., the invisible college itself), and institutions, and it will allow for systematic development of indices for the use of informal communication channels.

Despite the contribution of this current study to the research base and towards establishing best practices in this area, the study has limitations in its method and interpretation of its results.

This study focuses on the phenomenon of social media tools as informal communication channels; thus, the findings might not be generalizable to other informal communication channels. The study examines scholars at only one organization, the Institute of Public

Administration (IPA), located in Saudi Arabia, so the findings may not be generalizable to other organizations or governmental agencies in Saudi Arabia or elsewhere in the world.

Furthermore, the population for this study includes only faculty members who hold Ph.D. degrees, and thus, findings may not be applicable to other faculty members who do not have a doctoral degree. The samples from the male group were largely greater than the samples from the female group. This is because the majority of scholars who hold Ph.D. degrees at the institution are male. Despite of the equalization of scholars' numbers in academic fields, some academic fields have more scholars, such as law and human resources management fields. Also, the fact that I am a colleague of the faculty at the IPA may have affected the validity of the participants' responses.

Lastly, this study only employed a quantitative research method. Thus, it may not entirely unveil the participants' feedback with one method.

Implications and Conclusions

The theoretical implications of this study can be highlighted as providing current information on assessing the results' applicability to uses and gratifications theory and the MICM of using social media for scientific communication among scholars. Additionally, it provides information to adopt or improve such MICM. Specifically, while the study suggests they do use social media more heavily, more data needs to be collected as to whether or not they rely on it more, or prefer it instead of the traditional way.

One of the main objectives of this study was to build an MICM on the basis of the history of the invisible college and Lievrouw's (1989) distinction between social and structural processes. The present study focuses on the social processes of informal communication between scholars via social media, rather than on the structural processes that lead to scholarly

products or works.

Unlike most of the other studies that have investigated specific social media tools, this current study investigated scholars' perceptions of using the popular social media tools for scientific communication. In the current study, several popular social media, including Google+, YouTube, Twitter, and Facebook, were revealed to be the most frequently social media tools used by respondents for scientific communication, unlike in previous studies

To my knowledge, this study is the first to examine using social media for scientific communication among scholars, and that uses the uses and gratifications theory, coupled with building a new model for the modern invisible college.

The findings of this study show that 94.8% of IPA faculty members responded affirmatively that social media tools are widely used for scientific communication purposes. This indicates that these scholars have adopted social media tools for scientific communication and the two concepts of social media and scientific communication are clear to the scholars despite the fact that the concept of using social media for scientific communication is still in its early stages in public organizations in Saudi Arabia.

The positive attitudes of all participants may be due to the participants' recognition of social media benefits, especially regarding scientific communication issues, since most of the scholars use social media on a daily basis. Scholars' perceptions of using social media for scientific communication are considered to be a positive indicator because the scholars have already seen social media advantages and benefits. These results indicate that the most frequently used device for accessing social media platforms for communication is the smartphone. This indicates that scholars intended to use smartphone devices for scientific communication rather than other devices because smartphones are considered to be significantly more positive

compared to other devices according their size, mobility, availability, and their applications. The results of this study confirm the value of using social media tools for scientific communication among scholars, and especially Google+, which was mentioned in the study's questionnaire and in participants' comments.

The study shows that there are some barriers preventing the use of social media for scientific communication. Information overload, no privacy or confidentiality, workload, and lack of time as obstacles and challenges prevent more frequent use of social media.

The results of this study show that there were no statistically significant differences between most of the factors mentioned in the results (e.g., academic field, academic rank, age, and gender factors) and the use of social media for scientific.

Having research-based information on the use of social media for scientific communication will help institutions to encourage scholars to use social media for scientific communication more frequently and to apply this idea within their organizations. Moreover, the information from this study will provide high authorities and decision makers in public and private sectors with a better understanding of the way in which they can support their faculty members or scholars from an administrative perspective; for instance, by developing and delivering training on the use of social media for scientific communication, the benefits of using social media for scientific communication will more readily be employed through new technology for scientific communication purposes.

Recommendations

The outcome of this research indicates that it is important to conduct deep research into the advantages and the obstacles of using social media tools for scientific communication. Further investigation of scholars' experiences of using social media tools for scientific communication is

recommended.

Therefore, adoption of the modern invisible college model (MICM) is recommended for future research. This will enable researchers to better understand the invisible college concept, to develop the model, to develop methodology and to develop a research instrument that may be used in future research to test the applicability of various elements of the two main dimensions of the invisible college (i.e., social processes and structural processes) and to investigate the impact of both dimensions of the invisible college system. Therefore, it is recommended that a longitudinal study be conducted by determining and investigating the effect of using social media on scholars' behaviors.

Future studies might be conducted with the qualitative method or with a mixed method (combination of qualitative and quantitative methods) for the purpose of depth of corroboration and understanding of research elements and to generate detailed information on other societies and countries. It is also recommended that comparative research be conducted by using the MICM on different groups of scholars, on different organizations, and in other countries in order to generate detailed information on other societies or countries. It would be helpful to investigate the use of the WhatsApp tool mentioned by some participants in the results of this study, especially because it became a popular tool among scholars and other societies in the Middle East. This is especially relevant because the application was recently bought by Facebook.

Finally, there will need to be a real commitment on the part of the institutions in public and private sectors, and particularly in the Institute of Public Administration in Saudi Arabia, to provide scholars with adequate training about using social media for scientific communication. Scholars should be encouraged to participate and communicate with colleagues via social media tools for the purpose of scientific communication, and sufficient time should be offered for

scholars to use social media for scientific communication within institutions' boundaries.

APPENDIX A

ENGLISH VERSION OF THE SURVEY

Please select the most appropriate answer for each question. Please read each statement carefully, and check the response that best expresses your perception.

Section 1

1. Do you use social media for scientific communication purposes?

- No
 Rarely (once a month)
 Sometimes (twice a month)
 Often (once a week)
 Constantly (once or more a day)

If your answer is no, please skip from here to section 3.

Section 2

1. Which categories of tools do you use for your accessing social media platforms for your communication? Check as many as apply.

- Smartphones
 PCs
 Laptops
 Tablet computer

2. Indicate to what extent you use each of the following social media tools as scientific communication channels.

Social Media Tools		Never	Rarely	Sometimes	Often	Always
1	Twitter					
2	Facebook					
3	MySpace					
4	YouTube					
5	Flickr					
6	Skype					
7	Bloggers					
8	Google+					
9	LinkedIn					
10	Instagram					

11	Forums					
12	Others (_____)					

3. Indicate what social media tools you use most frequently as scientific communication channels.

Social Media Tools		Most Frequently
1	Twitter	
2	Facebook	
3	MySpace	
4	YouTube	
5	Flickr	
6	Skype	
7	Bloggers	
8	Google+	
9	LinkedIn	
10	Instagram	
11	Forums	
12	Others (_____)	

4. How do you decide which informal communication channel is appropriate? Indicate “yes” if you use each criterion, “no” if you do not, and “undecided” if you are not sure.

Statements	Yes	No	Undecided
1 I choose the appropriate social media that fit my needs, skills, and experiences.			
2 I choose the appropriate social media that help me to disseminate my scientific works.			
3 I choose the appropriate social media that are best for indicating an article link and text.			
4 I choose the appropriate social media to help me reach my goals.			
5 I use multiple different social media tools to support multiple goals.			
6 I think that selecting the appropriate social media tool will help me to identify the best way to reach my target audience.			

Section 3

1. Why do you use social media for scientific communication?

Statements	Yes	No	Undecided
1 I use social media because I need to explore new issues about my field.			

2	I use social media because I consider it a good tool for scientific communication.			
3	I use social media because I consider it a good tool to interact with scholars.			
4	I use social media because I consider it a good tool to introduce myself to others.			
5	I use social media because it gives me an opportunity to hear directly from others.			
6	I feel that using social media is appropriate to share my research papers.			
7	I feel that using social media is an appropriate tool to gain knowledge.			
8	I think that using social media is easy and a fast way to share my opinion.			
9	I think that social media is different from traditional forms of communication.			
10	I believe that using social media will improve my productivity.			

2. Indicate to what extent you perceive social media as useful for scientific communication.

Statements	Yes	No	Undecided
1 Has using social media tools made keeping in contact with scholars, researchers, and colleagues easier?			
2 Do you ever use social media tools to stay in touch with colleagues whom you rarely see in person?			
3 Does using social media tools facilitate your communication with scholars better than face-to-face contact?			
4 Does using social media tools help you to exchange and share information, knowledge, documents, and links with other scholars?			
5 Does using social media tools facilitate conversation and feedback with scholars?			
6 Does using social media tools help you to establish relationships with other scholars?			
7 Do you use social media to find information related to your research interest?			
8 Are you interested in using social media for scientific communication?			
9 Do you consider social media to be useful tools for scientific communication?			
10 Do you consider social media to be appropriate tools for scientific communication?			

3. What barriers prevent you from using social media tools for scientific communication purposes?

Statements	Yes	No	Undecided
------------	-----	----	-----------

1	I feel that the privacy of my personal information on social media is not protected.			
2	I do not trust social media because it will use my personal information for other purposes.			
3	I do not have enough skills to use social media.			
4	I do not have enough time to use social media.			
5	I do not use social media because of technical issues.			
6	I do not feel confident enough to use social media.			
7	I believe that some forms of social media require a lot of mental effort.			
8	I think social media is not an easy tool to set up and maintain.			

Section 4

Background information:

1. What is your gender?

Male Female

2. What is your age group?

20-29 30-39 40-49 50-59 60 or more

3. What is your academic rank?

Professor Associate professor Assistant professor Lecturer

4. What is your academic field of study? (Choices continue on next page.)

- _____ Materials Management
- _____ Health Administration
- _____ Statistics
- _____ Public Administration
- _____ Office Management
- _____ Engineering Management
- _____ Economics
- _____ Computer Science
- _____ Organizational Behavior
- _____ Public Relations and Media
- _____ Law
- _____ Business
- _____ English Language
- _____ Accounting
- _____ Finance
- _____ Information Science

_____ Human Resource Management
_____ Education
_____ Other: _____

Please add any comments or concerns that you want to include.

APPENDIX B

ARABIC VERSION OF THE SURVEY

الرجاء اختيار الإجابة المناسبة للأسئلة التالية:

القسم الأول:

- 1 كيف عادة تستخدم مواقع التواصل الإجتماعي (الشبكات الإجتماعية) لأغراض التواصل العلمي؟
- ___ لم أستخدمها أبدا
- ___ نادرا (مرة بالشهر)
- ___ أحيانا (مرتين بالشهر)
- ___ غالبا (مرة بالإسبوع)
- ___ دائما (مرة أو أكثر باليوم)
- إذا كانت إجابتك (لا/أبدا) الرجاء الانتقال للقسم الرابع.

القسم الثاني:

- 1 ما هي الوسائل التقنية التي تستخدمها للوصول لمواقع التواصل الإجتماعي (الشبكات الإجتماعية) لغرض التواصل مع الآخرين؟
- ___ الهاتف الذكي
- ___ جهاز الحاسب الآلي
- ___ الحاسب الشخصي
- ___ حاسب لوحي
- ___ أخرى (الرجاء ذكرها):
- 2 يرجى الإشارة إلى أي مدى يمكنك استخدام مواقع التواصل الإجتماعي (الشبكات الإجتماعية) التالية، كقنوات للتواصل العلمي؟

أنواع المواقع الإجتماعية	أبدأ	نادرا (مرة بالشهر)	أحيانا (مرتين بالشهر)	غالبا (مرة بالإسبوع)	دائما (مرة أو أكثر باليوم)
1 تويتر Twitter					
2 فيس بوك Facebook					
3 ماي سبيس MySpace					
4 يو تيوب YouTube®					
5 فليكر Flickr®					
6 سكايب Skype®					

					7	المدونات (Blogs (weblogs)
					8	جوجل+ Google+
					9	لينك دي ان LinkedIn
					10	انستجرام Instagram
					11	المنتديات Forums
					12	اخرى (الرجاء اذكرها.....)

3 يرجى الإشارة الى مواقع التواصل الإجتماعي (الشبكات الإجتماعية) الأكثر استخداما للتواصل العلمي؟
(اختر كل ما ينطبق).

الأكثر تكررا	انواع مواقع التواصل الإجتماعي	
	تويتر Twitter	1
	فيس بوك Facebook	2
	ماي سبيس MySpace	3
	يوتيوب YouTube®	4
	فليكر Flickr®	5
	سكايب Skype®	6
	المدونات (Blogs (weblogs)	7
	جوجل+ Google+	8
	لينك دي ان LinkedIn	9
	انستجرام Instagram	10
	المنتديات Forums	11
	اخرى (الرجاء اذكرها.....)	12

4 كيف تقرر أيا من قنوات الأتصال غير الرسمية (الشبكات الاجتماعية) يمكن أن تكون مناسبة لك؟

العبارة	نعم	لا	متعدد (محايد)
1 اقوم باختيار الشبكة الاجتماعية المناسبة التي تتوافق مع احتياجاتي والتي لا تتطلب المهارات والخبرات.			
2 اقوم باختيار الشبكة الاجتماعية المناسبة التي اتوقع منها أن تساعدني بنشر أعمالي وأبحاثي العلمية.			
3 اقوم باختيار الشبكة الاجتماعية المناسبة التي تقدم أو تعرض روابط لمقالات نصية بشكل جيد.			
4 اقوم باختيار الشبكة الاجتماعية التي تساعدني على تحقيق أهدافي.			
5 استخدم شبكات اجتماعية متعددة لتحقيق أهداف عدة.			
6 اعتقد أن اختيار الشبكات الاجتماعية المناسبة سوف تساعدني على تحديد أفضل طريقة للوصول إلى جمهور محدد (مستهدف).			

القسم الثالث:

1 لماذا تستخدم مواقع التواصل الإجتماعي (الشبكات الاجتماعية) للأغراض العلمية؟

العبارة	نعم	لا	متردد (محايد)
1 استخدمها لأنني اريد أن اكتشف آفاق جديدة في مجالي.			
2 استخدمها لأنها تعتبر وسيلة جيدة للتواصل العلمي.			
3 استخدمها لأنها تعتبر وسيلة جيدة للتفاعل مع العلماء.			
4 استخدمها لأنها طريقة جيدة لتقديم نفسي للآخرين.			
5 استخدمها لأنها تعطيني الفرصة للسمع من للآخرين وتلقي المعرفة بشكل مباشر.			
6 أشعر أن استخدمها يعتبر طريقة مناسبة لنشر أوراقي العلمية.			
7 أشعر ان استخدامها يعتبر طريقة مناسبة لاكتساب المعرفة.			
8 اعتقد انها وسيلة سريعة وسهلة للمشاركة بالأراء.			
9 اعتقد أنها طريقة مختلفة عن أشكال التواصل التقليدية.			
10 اعتقد أن استخدام مواقع التواصل الإجتماعي تحسن من أنتاجيتي.			

2 يرجى الإشارة إلى أي مدى تتصور أن مواقع التواصل الإجتماعي (الشبكات الاجتماعية) تعتبر مفيدة لعملية التواصل العلمي.

العبارة	نعم	لا	متردد (محايد)
1 هل استخدام مواقع التواصل الإجتماعي يسهل ويحافظ على التواصل مع الباحثين والعلماء والزملاء؟			
2 هل سبق واستخدمت مواقع التواصل الإجتماعي من أجل البقاء على اتصال مع الباحثين والعلماء والزملاء، الذين نادرا ما تراهم؟			
3 هل استخدام مواقع التواصل الإجتماعي يسهل تواصلك مع الأصدقاء والعلماء أكثر من الوسائل التقليدية؟			
4 هل استخدام مواقع التواصل الإجتماعي تساعدك على مشاركة العلماء في تبادل الآراء والمعلومات والأبحاث العلمية والوثائق والروابط الألكترونية؟			
5 هل استخدام مواقع التواصل الإجتماعي يسهل من المحادثات والحصول على ردود الفعل من الزملاء؟			
6 هل استخدام مواقع التواصل الإجتماعي يساعدك على تكوين علاقات مع علماء آخرين؟			
7 هل تستخدم مواقع التواصل الإجتماعي في الحصول على المعلومات أو المواضيع ذات الصلة بأهتماماتك العلمية او البحثية؟			
8 هل أنت مهتم باستخدام مواقع التواصل الإجتماعية في الأتصال العلمي؟			
9 هل تعتبر مواقع التواصل الإجتماعي أدوات مفيدة في عمليات الأتصال العلمي؟			
10 هل تعتبر مواقع التواصل الإجتماعي أدوات ملائمة للأتصال العلمي؟			

3 ما هي العوائق التي قد تحول من استخدام مواقع التواصل الاجتماعي لأغراض الأتصال العلمي؟

العبارة	نعم	لا	متعدد (محايد)
1 أشعر أن خصوصية معلوماتي الشخصية تكون غير محمية على مواقع التواصل الاجتماعي.			
2 لا اثق بمواقع التواصل الإجتماعية لأنه من السهل استخدام بياناتي الشخصية من قبل آخرين.			
3 لا أملك المهارة الكافية لإستخدام مواقع التواصل الاجتماعي.			
4 لا أملك وقت كافي لإستخدام مواقع التواصل الاجتماعي.			
5 لا استخدمها بسبب المسائل التقنية.			
6 لا أشعر بالثقة الكافية في استخدام مواقع التواصل الاجتماعي.			
7 اعتقد أن بعض مواقع التواصل الاجتماعي تتطلب الكثير من الجهد العقلي.			
8 اعتقد أنها ليست أدوات سهلة للأستخدام لأنها تحتاج لإعدادات وصيانة.			

القسم الرابع:

المعلومات العامة

1. الجنس:

ذكر أنثى

2. العمر:

29-20 سنة 39-30 سنة 49-40 سنة 59-50 سنة 60 سنة أو أكثر

3. الرتبة الأكاديمية:

استاذ استاذ مشارك استاذ مساعد أخرى (أرجوا ذكرها

4. التخصص الأكاديمي:

إدارة المواد الإدارة الصحية الإحصاء الإدارة العامة
 الإدارة المكتبية الإدارة الهندسية الأقتصاد والميزانية الحاسب الآلي
 السلوك التنظيمي تعليم القانون القطاع الأهلي
 اللغة الإنجليزية المحاسبة المعلومات الموارد البشرية
 العلاقات العامة والإعلام إدارة أعمال أخرى (.....)

من فضلك أضيف أي ملاحظات تودون ذكرها فيما يتعلق بمجال هذه الدراسة.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

APPENDIX C

LETTER OF ACCEPTANCE BY UNIVERSITY OF NORTH TEXAS INSTITUTIONAL
REVIEW BOARD



A green light to greatness.

OFFICE OF RESEARCH INTEGRITY AND COMPLIANCE

December 20, 2013

Dr. Shawne D. Miksa
Student Investigator: Mohammed Algarni
Department of Library and Information Sciences
University of North Texas
RE: Human Subjects Application No. 13-594

Dear Dr. Miksa:

In accordance with 45 CFR Part 46 Section 46.101, your study titled "The Use of Social Media in Informal Scientific Communication Among Scholars: Modeling the Modern Invisible College" has been determined to qualify for an exemption from further review by the UNT Institutional Review Board (IRB).

Enclosed are the consent documents with stamped IRB approval. Please copy and **use this form only** for your study subjects.

No changes may be made to your study's procedures or forms without prior written approval from the UNT IRB. Please contact Jordan Harmon, Research Compliance Analyst, ext. 4643, if you wish to make any such changes. Any changes to your procedures or forms after 3 years will require completion of a new IRB application.

We wish you success with your study.

Sincerely,

Patricia L. Kaminski, Ph.D.
Associate Professor
Chair, Institutional Review Board

PK:jh

UNIVERSITY OF NORTH TEXAS®

1155 Union Circle #310979 Denton, Texas 76203-5017
940.369.4643 940.369.7486 fax www.research.unt.edu

APPENDIX D

INTRODUCTORY LETTER TO FACULTY MEMBERS OF INSTITUTE OF PUBLIC
ADMINISTRATION (ENGLISH AND ARABIC VERSIONS)

University of North Texas Institutional Review Board

Informed Consent Notice

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: The Use of Social Media in Informal Scientific Communication Among Scholars: Modeling the Modern Invisible College

Student Investigator: Mohammed Algarni, University of North Texas (UNT) College of Information. **Supervising Investigator:** Shawne D. Miksa, Ph.D.

Purpose of the Study: You are being asked to participate in a research study which explores scholarly perceptions of using social media for scientific communication as informal communication channels among scholars at the Institute of Public Administration (IPA) in Saudi Arabia.

Study Procedures: You will be asked to complete a survey that will ask you about your opinions regarding of using social media for scientific communication as informal communication. This survey will take approximately 10 minutes to complete.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: The study is not expected to be of any direct benefit to you. However, the finding of this study may help researchers and practitioners to better understand the use of the informal communication channels among scholars. It also may benefit the IPA in order to provide any necessary training for its scholars about using the informal communication channels for scientific communication.

Compensation for Participants: None

Procedures for Maintaining Confidentiality of Research Records: The confidentiality of your responses will be recorded anonymously and treated in a confidential manner. No personal identifiable information is requested in the questionnaire.

Questions about the Study: If you have any questions about the study, you may contact Mohammed Algarni via at garnim@hotmail.com or Dr. Shawne Miksa via email at Shawne.Miksa@unt.edu

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Office of Research Services
University of North Texas
Last Updated: August 9, 2007

Page 1 of 2


Research Participants' Rights:

Your participation in the survey confirms that you have read all of the above and that you agree to all of the following:

- Mohammed Algarni has explained the study to you and you have had an opportunity to contact him with any questions about the study. You have been informed of the possible benefits and the potential risks of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- *(If recruiting students as participants, insert the following statement here) Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course.*
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You understand you may print a copy of this form for your records.

APPROVED BY THE UNT IRB

DATE:

 12-2013

جامعة شمال تكساس (مجلس المراجعة المؤسسية IRB)

اشعار بالموافقة

قبل الموافقة بالمشاركة في هذه الدراسة البحثية، من الضروري قراءة وفهم الغاية والفوائد والمخاطر من المشاركة في الدراسة.

عنوان الدراسة: استخدام وسائل الإعلام الإجتماعية في الإتصالات العلمية غير الرسمية بين العلماء: نمذجة الكلية الخفية الحديثة.

الباحث الرئيسي: محمد القرني، كلية المعلومات، جامعة شمال تكساس.

المشرف الدراسي: الدكتورة شاون دي ميكسا، كلية المعلومات، جامعة شمال تكساس.

الغرض من الدراسة: أنت مدعو للمشاركة في دراسة بحثية والتي تستكشف تصورات العلماء العلمية من استخدام وسائل الإعلام الإجتماعية لغرض التواصل العلمي من خلال قنوات الاتصال غير الرسمية بين العلماء بمعهد الإدارة العامة، المملكة العربية السعودية.

إجراءات الدراسة: سوف يطلب منك إكمال الإستبانة والتي تسأل عن أرائكم وتصوراتكم فيما يتعلق باستخدام وسائل الإعلام الإجتماعية للتواصل العلمي من خلال قنوات الاتصال غير الرسمية. تعبئة الإستبانة تحتاج 10 دقائق لإكمالها.

المخاطر المتوقعة: لا يتوقع ان يكون ثمة مخاطر أو مسؤولية في حالة المشاركة أو الرفض.

فوائد الدراسة: لا يتوقع أن تكون هناك أي فائدة مباشرة للمشاركة. ولكن، فإن النتائج من هذه الدراسة قد تساعد الباحثين و الممارسين لفهم الاستخدام الأفضل لقنوات الاتصال غير الرسمية بين الباحثين. كما أنها قد تفيد معهد الإدارة العامة من أجل إعداد وتطوير البرامج التدريبية اللازمة للعلماء والباحثين حول استخدام قنوات الاتصال غير الرسمية للاتصال العلمي.

التعويض للمشاركين : لا يوجد.

إجراءات حماية الخصوصية: خصوصيات المشاركين سيتم حمايتها ولن تقدم أو تذكر في مناقشة نتائج الدراسة، بالإضافة الى ذلك، أستبانة الدراسة لا تتطلب ذكر الأسم أو أي معلومات شخصية قد تساعد في التعرف على المشارك.

أسئلة عن الدراسة: إذا كان لديكم أي أسئلة حول هذه الدراسة، يمكنك الاتصال ب محمد القرني من خلال garnim@hotmail.com أو بالمشرفة الدراسة الدكتورة شاون ميكسا من خلال البريد الإلكتروني

Shawne.Miksa@unt.edu

شاكر لكم طيب تعاونكم، وتقبلوا خالص تحياتي،،،

المراجعة لحماية المشاركين : لقد تم استعرضت هذه الدراسة من قبل مجلس المراجعة المؤسسية (IRB) والتي تمت الموافقة عليها من قبلهم. كما يمكنكم الاتصال بهم على الرقم 565-3940 (940) في حالة وجود أي أسئلة بخصوص حقوق الموضوعات البحثية.

حقوق المشاركين في البحث:


مشاركتكم في الاستطلاع تؤكد أنك قد قرأت كل ما سبق وأنك توافق على كل ما يلي:

- أوضح لكم محمد القرني طبيعة الدراسة، كما أنه كان لديكم فرصة للاتصال به حول أي أسئلة أو استفسار حول الدراسة. أيضاً تم ابلاغكم حول الفوائد والمخاطر المحتملة للدراسة.
- عليك أن تدرك أنك لست ملزم بالمشارك في هذه الدراسة، ورفضك للمشاركة أو قرارك بالانسحاب لا تنطوي عليه أي عقوبة أو فقدان حقوق أو مزايا. وقد يختار أفراد الدراسة التوقف عن المشاركة في أي وقت.

- أنت تفهم لماذا تجرى هذه الدراسة وكيف سيتم تنفيذها.
- أنت تفهم حقوقك كمشارك بالدراسة وإنك توافق طوعاً على المشاركة في هذه الدراسة.
- أنت تفهم أنه قد يتم طباعة نسخة من هذا النموذج لسجلاتك.

APPROVED BY THE UNT IRB

DATE:

 12-2013

REFERENCES

- Abdulhamid, N. & Salim, J. (2010). Inter-organizational knowledge transfer through Malaysia e-government IT outsourcing: A theoretical review. *World Academy of Science, Engineering and Technology*, 4(6), 1460-1470.
- Agarwal, S. & Mital, M. (2009). An exploratory study of Indian University students' use of social networking websites: Implications for the workplace. *Business Communication Quarterly*, 72(1), 105-110.
- Azudin, N., Ismail, M., & Taherali, Z. (2009). Knowledge sharing among workers: a study on their contribution through informal communication in Cyberjaya, Malaysia. *Knowledge Management & E-Learning: An International Journal*, 1(2), 139-162.
- Babbie, E. (1998). *Survey research methods* (2nd ed.). Belmont, CA: Wadsworth Publishing Company.
- Babbie, E. (2009). *The practice of social research* (12th ed.). Belmont, CA: Thomson/Wadsworth. Print.
- Baruah, T. (2012). Effectiveness of social media as a tool of communication and its potential for technology enabled connections: A micro-level study. *International Journal of Scientific and Research Publications*, 2(5), Retrieved from http://www.ijsrp.org/research_paper_may2012/ijsrp-may-2012-24.pdf
- Bik, M. B. & Goldstein, M. C. (2013). An introduction to social media for scientists. *PLoS Biol*, 11(4), Retrieved from <http://www.plosbiology.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pbio.1001535&representation=PDF>

- Boyd, D. M., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*, 13(1), Retrieved from <http://jcmc.indiana.edu/vol13/issue1/boyd.ellison.html>
- Borgman, C. (1990). Editor's introduction. In C. Borgman (Ed.), *Scholarly communication and bibliometrics* (pp. 10-27). Newbury Park, CA.: Sage.
- Borgman, C. L. (1993). Round in circles: The scholar as author and end-user in the electronic environment. In H. Woodward & S. Pilling (Eds.), *The international serials industry* (pp. 45-59). London: Gower
- Broadus, R. (1987). Toward a definition of "bibliometrics." *Scientometrics*, 12(5-6), 373-379.
- Bullas, J. (2014). 22 social media facts and statistics you should know in 2014. Retrieved from <http://www.jeffbullas.com/2014/01/17/20-social-media-facts-and-statistics-you-should-know-in-2014/>
- Case, D. O. (2007). *Looking for information: A survey of research on information seeking, needs, and behavior* (2nd ed.). Boston: Academic Press.
- Caldas, A. (2002). Electronic "invisible colleges" and the dynamics of research networks. *Scientific Communications*, 56-63.
- Cao, Y., Ajjan, H. & Hong, P. (2013), Using social media applications for educational outcomes in college teaching: A structural equation analysis. *British Journal of Educational Technology*, 44, 581-593.
- Charney, T., & Greenberg, B. (2002). Uses and gratifications of the intern. In C. A. Lin, & D. J. Atkin (Eds.), *Communication, technology and society: Audience adoption and uses* (pp. 379-407). Creskill, NJ: Hampton Press
- Chatman, E. (1991). Life in a small world: Applicability of gratification theory to information-

- seeking behavior. *Journal of the American Society for Information Science*, 42(6), 438-449.
- Chen, B. & Bryer, T. (2012). Investigating instructional strategies of using social media in formal and informal learning. *International Review of Research in Open and Distance Education*. Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/1027>
- Choo, C.W. & Auster, E. (1993). Environmental scanning: Acquisition and use of information by managers. *Annual Review of Information Science and Technology*, 28, 279-314.
- Chubin, D. (1983). *Sociology of science: An annotated bibliography on invisible college 1972-1981*. New York: Garland.
- Chubin, D. (1985). Beyond invisible college: Inspirations and aspirations of post-1972 social studies of science. *Scientometrics*, 7(3-6), 221-254.
- Correa, T., Hinsley, A. W., & Zuniga, H. G. D. (2010). Who interacts on the Web? The intersection of users' personality and social media use. *Computers in Human Behavior Journal*, 26, 247-253.
- Crane, D. (1972). *Invisible colleges: Diffusion of knowledge in scientific communities*. Chicago: University of Chicago Press.
- Crawford, S. (1971). Informal communication among scientists in sleep research. *Journal of the American Society for Information Science*, 22, 301-310.
- Cruz, F. & Jamias, S. (2013). Scientists' use of social media: The case of researchers at the University of the Philippines Los Banos. *First Monday*, 18(4), Retrieved from <http://firstmonday.org/ojs/index.php/fm/article/view/4296>
- Cummings, J. (2004) Work groups, structural diversity, and knowledge sharing in a global organization. *Management Science*, 50(3), 352-364.

- Driscoll, D. L. (2011). *Introduction to primary research: Observations, surveys, and interviews*. In Charles Lowe & Pavel Zemliansky (Eds.), *Writing spaces: Readings on writing* (pp. 153-174). San Francisco, CA: Parlor Press
- Eperen, L. V. & Marincola, F. M. (2011). How scientists use social media to communicate their research, *Journal of Translational Medicine*, 9(199), Retrieved from <http://www.translational-medicine.com/content/pdf/1479-5876-9-199.pdf>
- Faibisoff, G., & Ely, D. P. (1976). Information and information needs. *Information Reports and Bibliographies*, 3(5), 2-16.
- Field, A. (2009). *Discovering Statistics Using SPSS*. Sage Publications.
- Foregger, S. (2009). Uses and gratifications of facebook.com. *Dissertation Abstracts International Section A*, 69. (UMI No. 3331906)
- Fraenkel, J. R. & Wallen, N. E. (2009). *How to design and evaluate research in education*. (7th Ed.). United States: McGraw-Hill.
- Fulton, J. F. (1932). Robert Boyle and his influence on thought in the seventeenth century. *ISIS*, 18(1), 77-102.
- Garvey, W. D., & Griffith, B. C. (1972). Communication and information processing within scientific disciplines-empirical findings for psychology. *Information Storage and Retrieval*, 8(3), 123-136.
- Garvey, W. D., & Griffith, B. C. (1967). Scientific communication as a social system. *Science*, 157(3792), 1011-1016.
- Garvey, W. D. (1979). *Communication: The essence of science*. New York: Pergamon.
- Gay, L. (1996). *Educational research: Competencies for analysis and application*. Upper Saddle River, NJ: Prentice-Hall, Inc.

- Gatewood, R. D., & Field, H. S. (2001). *Human Resource Selection*. (5th Ed.). Mason, OH: South-Western Thomson Learning.
- Goodrum, A., McCain, K., Lawrence, S., & Giles, C. (2001). Scholarly publishing in the Internet age: a citation analysis of computer science literature. *Information Processing and Management*, 37, 661-675.
- Greenhow, C. (2009). Social scholarship: Applying social networking technologies to research practices. *Knowledge Quest*, 37(4), 42-47.
- Grosseck, G., Bran, R., & Tiru, L. (2011). Dear teacher, what should I write on my wall? A case study on academic uses of Facebook. *Procedia Social and Behavioral Sciences*, (15), 1425–1430.
- Gruzd, A. & Staves, K. (2011). *Trends in scholarly use of online social media*. Position paper presented at the Workshop on Changing Dynamics of Scientific Collaboration, the 44th Annual Hawaii International Conference on System Sciences (HICSS), Retrieved from <http://dalspace.library.dal.ca/handle/10222/14427>
- Gruzd, A., Staves, K., & Wilk, A. (2012). Connected scholars: Examining the role of social media in research practices of faculty using the UTAUT model. *Computers in Human Behavior*, (28), 2340-2350.
- Gu, F. & Widen-Wulff, G. (2011). Scholarly communication and possible changes in the context of social media A Finnish case study, *The Electronic Library*, 29(6), 762-776.
- Hamid, S., Waycott, J., Chang, S. & Kurnia, S. (2011). *Appropriating online social networking (OSN) activities for higher education: Two Malaysian cases*. In G. Williams, P. Statham, N. Brown & B. Cleland (Eds.), *changing demands*, (pp. 526-538).

- Haythornthwaite, C. & Wellman, B. (1998). Work, friendship, and media use for information exchange in a networked organization. *Journal of the American Society for Information Science*, 49(12), 1101–1114.
- Hellou, A. M. & Rahim, N. Z. (2011). The influence of social networking sites on students' academic performance in Malaysia. *International Conference on Internet Studies*, 8-10.
- Hew, K. F. (2011). Students' and teachers' use of Facebook. *Computers in Human Behavior*, 27, 662–676.
- Hunter, M. (2004). The Robert Boyle project. University of London. Retrieved from <http://www.bbk.ac.uk/Boyle/>
- Hunter, M. & Littleton, Ch. (2001). The work-diaries of Robert Boyle: A newly discovered source and its Internet publication. *Notes Rec. R. Soc. London*, 55(3), 373-390.
- Howard, J. (2011). Social media lure academics frustrated by journals. *Chronicle of Higher Education*, Retrieved from <http://chronicle.com/article/Social-Media-Lure-Academics/126426/>
- Internet World Stats. (August 12 2013). Internet growth statistics: Today's road to e-commerce and global trade Internet technology reports. Retrieved from <http://www.internetworldstats.com/emarketing.htm>
- Ipe, M. (2003). Knowledge sharing in organizations: A conceptual framework. *Human Resource Development Review*, 2(4), 337-359
- Katz, E. (1959). Mass communication and the study of popular culture: An editorial note on a possible future for this journal. *Studies in Public Communication*, 2, 1-6.

- Katz, E, Blumler, J.G., & Gurevitch, M. (1974). *Utilization of mass communication by individual in the uses of mass communications: Current perspective on gratifications research*. Ed. J.G Blumler and E. Katz, Beverly Hills, CA: Sage; 19-32.
- Kotter, J. (1982). What effective general managers really do. *Harvard Business Review*, 60(2), 157-169.
- Kwok, S & Gao, S. (2006). Attitude towards knowledge sharing behavior. *Journal of Computer Information Systems*, 46(2) 45-51.
- Larose, R., & Eastin, M. S. (2004). A social cognitive theory of Internet use and gratifications: Towards a new model of media attendance. *Journal of Broadcasting and Electronic Media*, 48(3), 358-377.
- Lee, J. (2001). The impact of knowledge sharing, organizational capacity and partnership quality on IS outsourcing success. *Information and Management*, 38(5), 323-335.
- Leedy, P. D., & Ormrod, J. E. (2001). *Practical research: planning and design*. Upper Saddle River, Nj: Prentice-Hall, Inc.
- Lesser, E., & Storck, J. (2001). Communities of practice and organizational performance. *IBM Systems Journal*, 40(4), 831-841.
- Lievrouw, L. (1989). The invisible college reconsidered: Bibliometrics and the development of scientific communication theory. *Communication Research*, 16(5), 615-628.
- Lievrouw, L. A., & Carley, K. (1990). Changing patterns of communication among scientists in an era of telescience. *Technology in Society*, 12(4), 457-477.
- Line, M. B. (1982) *Library Surveys: An introduction to the use, planning procedure and presentation of surveys*. (2nd Ed.). London: Clive Bingley.
- Livingstone, S. (1997). *The work of Elihu Katz: Conceptualizing media effects in context*. In J.

- Corner, P. Schlesinger & R. Silverstone (Eds.), *International Handbook of Media Research: A Critical Survey* (pp. 18-47). London: Routledge.
- Lull, J. (1995). *Media, communication, culture: A global culture*. New York: Columbia University Press
- Luthans, F. (1988). Successful vs. effective real managers. *Academy of Management Executive*, 2(2), 127-132.
- McKie, D. (1960). The origins and foundations of the Royal Society of London. *Notes and Records of the Royal Society of London* 15(Jul, 1960), 1-37.
- Marouf, L. N. (2007) Social networks and knowledge sharing in organizations: A case study. *Journal of Knowledge Management*, 1(16), 110-125.
- Mingers, J. (2001). Combining IS research methods: Towards a pluralist methodology. *Information Systems Research*, 12(3), 240-259.
- Moran, M., Seaman, J., & Tinti-Kane, H. (2011). Teaching, learning, and sharing: how today's higher education faculty use social media. Pearson Learning Solutions, the Babson Survey Research Group, and Converseon Research Report, Retrieved from <http://www.pearsonlearningsolutions.com/educators/pearson-social-media-survey-2011-bw.pdf>
- Newhagen, J. E., & Rafaeli, S. (1996). Why communication researchers should study the Internet: A dialogue. *Journal of Communication*, 46(1), 4-13.
- Nonaka, I. (1991). The knowledge creating company, *Harvard Business Review*, (p. 96).
- Osterrieder, A. (2013). The value and use of social media as communication tool in the plant sciences. *Plant Methods*, (9)26, Retrieved from <http://www.plantmethods.com/content/9/1/26>

- Owen, R., & Humphrey, P. (2009). The structure of online marketing communication channels. *Journal of Management & Marketing Research*, 3, 54-62.
- Oyekan, A. (2007). The usage of the intranet and its impact on organizational knowledge sharing: An exploratory investigation of a public hospital. Retrieved from <http://epress.lib.uts.edu.au/research/bitstream/handle/10453/20028/02Whole.pdf?sequence=2>
- Paisley, W. (1984). Communication in the communication sciences. In B. Dervin & M. Voight (Eds.), *Progress in communication sciences*, (pp. 1-43). Norwood, NJ: Ablex.
- Paisley, W. (1972). The role of the invisible college in scientific information transfer. *American Education Research Association*, 1(4), pp. 5-8.
- Paisley, W. (1968). Information needs and uses. *Annual review of information science and technology*, (3), 1-30.
- Papacharissi, Z. (2009). *Uses and gratifications*. In stacks and salwen (eds.) An integrated approach to communication theory and research, 2nd ed., (p. 137-152), New York, NY: Routledge.
- Parveen, N. (2011). Use of social networking site (Facebook) in making awareness among the library and information science professionals of university libraries of U.P: a case study. *International Journal of Digital Library Services*, 1(1), Retrieved from <http://www.ijodls.in/uploads/3/6/0/3/3603729/ijodl2.pdf>
- Priem, J. & Hemminger, B. (2010). Scientometrics 2.0: Toward new metrics of scholarly impact on the social web, *First Monday*, 15(7), Retrieved from <http://journals.uic.edu/ojs/index.php/fm/article/view/2874/2570>
- Price, D. J. de Solla. (1963). *Little science, big science*. New York: Columbia University Press.

- Price, D. J. de Solla. (1986). *Little science, big science ... and beyond*. New York: Columbia University Press.
- Pritchard, A. (1969). Statistical bibliography or bibliometrics? *Journal of Documentation*, 25, 358-359.
- Procter, R., Williams, R., & Stewart, J. (2010). If you build it, will they come? How researchers perceive and use Web 2.0. London: Research Information Network (RIN).
- Raacke, J. & Bonds-Raacke, J. (2008). MySpace and Facebook: Applying the uses and gratifications theory to exploring friend-networking sites. *CyberPsychology & Behavior*, 11(2), 169-174.
- Rainie, L. (2010). How media consumption has changed since 2000. Pew Internet and American Life Project. Retrieved from <http://www.pewinternet.org/~media/Files/Presentations/2010/Jun/2010%20-%20062410%20-%20syracuse%20newhouse%20MOB%20conf%20NYC%20pdf.pdf>
- Reid, S. (2007). Communication channels and the adoption of Web-based courses by university professors, *Journal of Interactive Online Learning*, 6(3), 142-158.
- Rosengren, K. E. (1974). *Uses and gratifications: A paradigm outlined*. In J. G. Blumler & E. Katz (Eds.), *The uses of mass communications: Current perspectives on gratifications research* (pp. 269-286). Beverly Hill, CA: Sage.
- Rowlands, I., Nicholas, D., Russell, B., Canty, N., and Watkinson, A. (2011). Social media use in the research workflow, *Learned Publishing*, 24(3), 183-195.

- Rubin, A. M. (1994). *Media uses and effects: A uses and gratifications perspective*. In J. Bryant and D. Zillmann (Eds.), *Media Effects: Advances in Theory and Research* (pp. 417-436). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ruggiero, T.E. (2000). Uses and gratifications theory in the 21st century. *Mass Communication & Society*, 3(1), 3-37.
- Sajithra, K. & Patil, R. (2013). Social Media-History and Components, *Journal of Business and Management*, 7(1), 69-74.
- Saunders, M., Lewis, P. & Thornhill, A. (2000). *Research methods for business students*. (2nd Ed). Essex: Pearson Education.
- Shafique, F.; Anwar, M. & Bushra, M. (2010). Exploitation of social media among university students: A case study, *Webology*. Retrieved from <http://www.webology.org/2010/v7n2/a79.html#11>
- Shehab, M., Squicciarini, A., Ahn, G. & Kokkinou, I. (2012). Access control for online social networks third party applications. *Computers & Security*, 31, 897-911.
- Simco, N., & Warin, J. (1997). Validity in image based research: An elaborated illustration of the issues. *British Educational Research Journal*, 23(5), 661-673.
- Simsek, Z. & Veiga, J. F. (2001). A primer on Internet organizational surveys. *Organizational Research Methods*, 4(3), 218-235.
- Singh, D. K. & Gill, M. S. (2011). Use of social networking sites by the research scholars: A study of Guru Nanak Dev University. Amritsar, *Library Herald*, 49(3), 229-241.
- Sudman, S., & Bradburn, N. M. (1982). *Asking questions: A practical guide to questionnaire design*. San Francisco: Jossey Bass.

- Talja, S. (2002). Information sharing in academic communities: Types and levels of collaboration in information seeking and use. *New Review of Information Behavior Research*, 3, 143–159.
- Taylor-Powell, Ellen (1998). Questionnaire design: Asking questions with a purpose. University of Wisconsin-Extension, Cooperative Extension. Retrieved from http://cf.uwex.edu/ces/pubs/pdf/G3658_2.PDF
- Tuire, P. & Erno, L. (2001). Exploring invisible scientific communities: Studying networking relations within an educational research community. A Finnish case. *Higher Education*, 42(4), 493-513.
- Tyson, W. (2010). *Pitch perfect: communicating with traditional and social media for scholars, researchers, and academic leaders*. (1st ed.), Sterling, Va.: Stylus Pub.
- Urista, M. A., Dong, Q., & Day, K. D. (2009). Explaining why young adults use MySpace and Facebook through uses and gratifications theory. *Human Communication*, 12(2), 215-229.
- Veletsianos, G. & Kimmons, R. (2013). Scholars and faculty members' lived experiences in online social networks. *Internet and Higher Education*, 16, (p. 43-50).
- Veletsianos, G., Kimmons, R., & French, K. (2013). Instructor experiences with a social networking site in a higher education setting: Expectations, Frustrations, Appropriation, and Compartmentalization. *Educational Technology, Research and Development*, 61(2), 255-278.
- Veletsianos, G. & Kimmons, R. (2012). Assumptions and challenges of open scholarship. *International Review of Research in Open and Distance Learning*, 13(4), 166-189.

- Veletsianos, G. (2012). Higher education scholars' participation and practices on Twitter. *Journal of Computer Assisted Learning, 28*, 336-34.
- Wagner, C.S. (2008). *The new invisible college: science for development*. Washington (D.C.): Brookings Institution Press.
- Walsh, S., Kucker, N., Maloney, & Gabbay, S. (2000). Connecting minds: Computer-mediated communication and scientific work. *Journal of the American Society for Information Science, 51*(14), 295-305.
- Warnakula, W. M., & Manickam, B. (2010). Employees' behaviour in online social networking websites (SNSs). *Tropical Agricultural Research, 22*(1), 94-106.
- Webster, Ch. (1974). New light on the invisible college the social relations of English science in the mid-seventeen century. *Transactions of the Royal Historical Society, 5*(24), 19-42.
- Whittaker, S. & Sidner, C. (1996). Email overload: exploring personal information management of email, In CHI'96: Proceedings of the SIGGHI conference on Human factors in computing systems, ACM Press, 276-283.
- Zakaria, M., Watson, J. & Edwards, S. (2010). Investigating the use of web 2.0 technology by Malayasin students. *Multicultural Education and Technology journal, 4*(1), 12-29.
- Zuccala, A. (2004). *Revisiting the invisible college: A case study of the intellectual structure and social process of singularity theory research in mathematics*. Unpublished doctoral dissertation, University of Toronto.
- Zuccala, A. (2006). Modeling the invisible college. *Journal of the American Society for Information Science and Technology, 57*, 152-168.